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THE APPLICATIONS OF ELECTRICITY.

A COMMUNICATION from a correspondent which we publish this week, appears to indicate a new direction in which electricity may, perhaps, eventually be employed. At present we fear its cost would be prohibitive when compared with the methods now in use for accomplishing the objects in view. One may expect that, ere long, reliable figures will be published relating to the expenses attached to the working of electrical tramways both at home and abroad. We trust that the system of "telpherage" proposed by Professors Fleeming Jenkin and Ayrton & Perry will soon assume a practical shape, or rather, we should say, be seen in practical operation. It appears eminently adapted for the purpose of hauling minerals from the pit's mouth to the river side in such a case as that mentioned in our correspondent's letter. Apparently, but little experience has yet been obtainable as to how far, and in what manner, electricity may be employed for the purpose of lifting heavy loads from the bottom of a pit to its head. Dr. Hopkinson is one of the few who could give valuable information on this point, but we doubt whether even he would advocate electrical lifts for mining purposes. With respect to the electrical propulsion of mineral-laden barges along a river, we feel sure that Mr. Reckenzaun would be found equal to bringing such a matter to a successful issue, although, so far, attempts in the direction of electrical navigation have been of a purely experimental character.

Many persons whose opinions are worthy of every consideration, have expressed their firm conviction that electrically-propelled boats will play an important part in the traffic of our rivers, and we need only refer to the excellent paper by Mr. Reckenzaun on this very subject, published in our columns but a few weeks since, together with the discussion which followed, to show how much interest centred itself in that gentleman's remarks.

We hope that the letter to which we have referred may have the effect of bringing more prominently before our electricians a path which has been but little followed, and that the result may be the introduction of some scheme which will bring the varied applications of electricity still more to the fore.

MISLEADING REPORTS.

ONE of the most extraordinary (we had almost said barefaced) attempts—let us trust it has been an unsuccessful one—to obtain money from the pockets of the investing British public, was that brought forward by the Spiral Telephone Wire Syndicate during the present month. The wire itself, on the marvellous and purely imaginary qualities of which the promoters relied to effect their object, has already been made the subject of critical comment in our pages. In the prospectus issued by the Syndicate we failed to notice any publication of tests made of the wire by any English electrician of eminence upon whose report the public could place confidence; not only this, but the names of any recognised American authorities were also conspicuous by their absence, although it was stated that the invention had been proved to possess all the wonderful merits claimed for it in the United States. But that about which we feel most concerned is, neither the simplicity of the public nor the intentions of the Syndicate, but that anyone in this country with an electrical training should have been so far led away as to make a report to the effect that the spiral wire possessed advantages over that which is at present in daily use. That this report was an erroneous one we felt certain at the time of its publication, and our suggestion as to a probable source of error, appears by the after tests taken by Mr. A. R. Bennett, and the admissions of the gentleman to whose report we allude, to have been correct. Although the report in question was, we understand, a private communication, that does not make the mistake less serious, since the writer does not appear to have had any guarantee that the matter would be treated confidentially. Had this been done, but little harm could have resulted, but as it is, we fear that the gentleman who so unfortunately committed to writing, tests—the unreliable nature of which should have been apparent even to him—has unintentionally weakened the confidence which might have been placed in his competency as an electrical engineer, and may also have lessened the influence of professional reports in general.

THE ELECTRICAL TRANSMISSION AND DISTRIBUTION OF ENERGY.*

By MARCEL DEPREZ.

* Translated from *La Lumière Electrique.*

(*Continued from page* 223.)

DISTRIBUTION OF ENERGY.

Graphic Theory of Dynamo-electric Machines.

The distribution of energy supposes that a certain number of apparatus fit for utilising electricity, which may be of different nature and power, being placed in connection with one and the same generator, the latter is arranged so as to produce the energy necessary for their working, and to send it continually to each of them. Each apparatus may further be arrested or set in action at any moment, the production of electricity being bound to conform constantly to these various conditions.

We see that under these novel conditions the total quantity of energy to be produced is constantly varying. We know that this quantity is represented by the expression E I, E being the electromotive force of the generator, I the intensity of the current. This product then must be made to vary according to the demand of the recipient apparatus. We may act upon both factors at once, but it is clear that simple methods will consist in acting separately upon each.

We may, therefore:—

1. Leave I constant and let E vary.
2. Leave E constant and let I vary.

The former method will lead us to place all the recipients in one and the same circuit, traversed by a current, the intensity of which will be I; the apparatus will be then arranged in series.

The second method requires us to place the apparatus in distinct circuits, abutting on the two poles of the generator, the difference of potential of which, *e*, will be constant; the apparatus will then be arranged on derived currents.

A comparison will render these two methods of arrangement intelligible.

Suppose that it is required to utilise a fall of water by dividing it among several water-wheels, or similar apparatus. We may then, if the height is sufficient, place them one above another, each receiving the totality of the water, but utilising only a part of its height of fall. In this case, if we wish to introduce an additional apparatus, it will not be necessary to change the supply of water, but it will be needful to increase the height of the fall. The apparatus are then in series or in tension. We may, on the other hand, place the recipient apparatus side by side, each of them utilising the entire height of the fall, but receiving only a part of the water. In case of adding another apparatus it is then necessary, without interfering with the height of the fall, to increase the flow of the river, so as to supply the additional apparatus; the several apparatus are then placed in derivation.

Let us return to the distribution of electricity.

In the former system, if the number of recipient apparatus happens to vary, whilst the intensity remains constant, notwithstanding the resistances or electromotive forces introduced into the circuit, the intervention of a regulator, causing the potential to vary, is obviously necessary.

In the second system its necessity is less directly visible. It might, indeed, seem that on taking a generator of constant electromotive force, E, in virtue of Ohm's law, any circuit whatever of the resistance, R, will receive a current of the intensity $I = \frac{E}{R}$. If we add a second similar circuit, the resistance, composed of the two conductors, will be reduced to half, and the intensity, becoming $I' = \frac{E}{\frac{R}{2}}$ will be doubled, and the supply of the second circuit secured. These deductions are false, because no account has been taken of an element which hitherto we have not had occasion to point out in an especial manner, and which is the internal resistance of the generator. If we represent this resistance by *r*, the external resistance being R, the true expression of the intensity will be $I = \frac{E}{r + R}$; the addition of an exterior circuit, similar to the former, will give $I' = \frac{E}{r + \frac{R}{2}}$. We see at once that this expression is not double the former. The supply of the two apparatus, therefore, can only be secured, as in the former case, by introducing a regulator, which will cause the electromotive force, E, to vary in such a manner that the difference of the potential, *e*, at the extremities of the generator, may be always brought back to its former value, which the variation of the external resistance tends to remove.

The formula $I = \frac{E}{r + R}$ shows that if *r* is very small in comparison with R, we approximate to an apparatus, the resistance of which will be nil; the regulation, therefore, becomes less necessary. In certain restricted cases, under special conditions, we may arrive practically at installations acting in a satisfactory manner. This, however, does not constitute a solution of the problem, and would be quite inapplicable in an extensive circuit with very different kinds of apparatus, the more so as in any distribution of importance the transmission to a distance becomes an element which must be taken into account. We are then led, as we know, to employ electricity at very high tensions, and consequently to increase the resistance of the generating apparatus, two conditions not readily separable.

It must, then, be admitted that to effect the distribution of energy we must plan a system of regulation which will keep the intensity constant if the apparatus are placed in series, or the difference of potential constant at the points of departure, if they are arranged in derivation.

In all cases a complete solution of the question of distribution must fulfil three conditions:

1. All the recipient apparatus must each receive its share of energy; it must act in an independent manner without mutual interference.

2. The regulation necessary for this purpose should be effected instantaneously and automatically by the sole action of the apparatus and without the intervention of attendants.

3. The regulation should be such that the generator produces at each moment only the total quantity of electricity necessary for the supply of the apparatus in action.

Both the methods of grouping described above may be applied; nevertheless, the arrangement in derivation is preferable in the great majority of cases. The regulation is more easy, and, besides, the arrangement in series places all the apparatus in a reciprocal dependance much more complete than in the other system; so that a defect in any one point of the circuit has a much more serious effect upon the whole.

The theorems about to be demonstrated will, however, permit a solution of both cases.

In the studies which we are about to commence, we shall consider principally the distribution of mechanical power, as being the most important object; nevertheless, the solutions are absolutely general.

Graphic Representation of the Working of the Machines, Characteristic for a given speed.

We will take a continuous current dynamo-machine and cause it to revolve at a constant rate.

We will then give it several circuits, such that the resistance furnished by each of them (comprising that of the machine) may be well known. For each resistance, R, we will measure the intensity, I, and calculate E = R I.

In various former documents will be found the method of constructing the characteristic curve expressed as, "In a machine of a known current let us suppress the communication between the circuit which surrounds the electro-magnets and forms the magnetic field on the one part, and on the other the conductor coiled upon the ring or the bobbin and forming the induced circuit. For the inducing circuit let us direct by means of a foreign source, currents of known intensity, causing the induced ring to turn with a known speed, and finally, let us measure the electromotive force produced on the induced circuit." This method of procedure would be inaccurate because we should eliminate the action which in real work the current circulating in the inductor exerts upon the magnetic field.

We have, for every experiment, a value of E corresponding to a value of I. Taking I for the abscissa and E for ordinate, we can form a curve (fig. 5), which we call the characteristic of the machine experimented on. The form of this curve depends on the construction of the machine, the dimensions and the proportions of its various parts. It represents the action and distinctly characterises the apparatus. This curve, as it will be seen, enables us to solve all the questions which may be put on the use of an appliance of this nature.

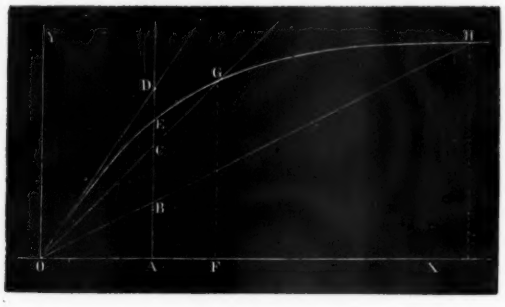


FIG. 5.

For any intensity, I, the curve gives us at once the corresponding value of E for the speed, V, chosen.

We hence infer directly the value of the resistance, for, from Ohm's law, $I = \frac{E}{R}$ we deduce the expression $R = \frac{E}{I} = \frac{GF}{OF} =$ tang. GOF; the total resistance, R, in the system is therefore represented by the tangent of an angle.

If we wish to express this numerically, we must take on the axis of *x* any length, OA, whatever; we erect at this point an indefinite ordinate upon which is set out a length = OA. This length will represent the ohm, since it represents the formula $\frac{E}{I} = 1$ ohm, corresponding to the tangent 45° = 1; it serves, therefore, to graduate the ordinate, OD. If we consider any point whatever, H, of the characteristic, the length AB, cut off by the line, OH, represents the resistance in ohms.

The examination of this curve leads to the explanation of several interesting phenomena. The form in which we give it is that which it takes for Gramme machines of the ordinary type at mean speeds, as theory had led me to foresee, and as experience has since fully demonstrated.

Let us set out with a mean, OG, of the resistance and cause it to decrease; the line, OG, will become lower towards OX in the direction OH; we see that the electromotive force increases at first rapidly, then more and more slowly, and finally becoming stationary; the curve tending to become parallel to the axis of *x*. This depends on the fact that the magnetisation of the soft iron of the electro-magnets does not increase indefinitely, and that there is a point of saturation which we do not reach in reality, but towards which we tend and almost reach, and which forms probably an asymptote of the curve.

On the other hand, instead of diminishing the resistance, let us increase it; the line, OG, will turn towards the axis of *y*; it will thus intersect the curve nearer and nearer to its origin, and for the position, OD, it becomes tangential. At this point there is no longer any current; this is a phenomenon hitherto not well explained. By means of the characteristic we see how there is a given resistance at which the excitement is nil and the machine ceases to act.

Characteristic for Different Velocities and Different Methods of Coiling.

We have established the characteristic for a given velocity of rotation, V; if we wish to have the characteristic of the same

machine for a different velocity, v', it is sufficient to multiply the ordinates by $\frac{v'}{v}$. To one and the same intensity there corresponds one and the same magnetic field. The electromotive forces with different velocities are then proportional to different speeds, according to the laws of induction.

This construction will give a transformation of the curve like that represented in fig. 6.

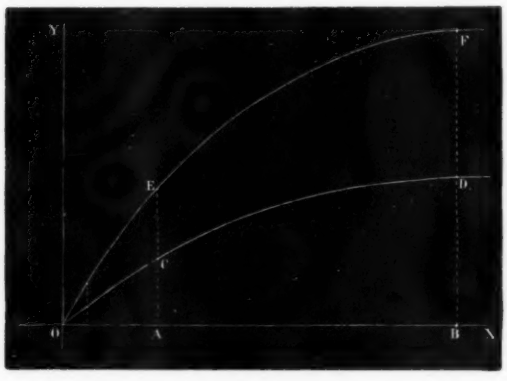


FIG. 6.

It will be remarked that if in place of changing the speed of rotation we change the coiling of the ring, *i.e.*, if we modify the number of turns of wire upon the ring without modifying the other conditions, and especially the volume of the ring (which is effected by using more coils of a finer wire), the new characteristic is obtained by an analogous transformation; t being the original, and t_1 the new number of coils, the electromotive force which, other things being equal, is proportional to the length of the wire, will be multiplied by $\frac{t}{t_1}$.

If we consider (fig. 6) the characteristic, O C D, corresponding to the velocity, v, and the characteristic, O E F, corresponding to the velocity, v_1, the resistance for one and the same intensity will be given by the tangents of the angles, C O A and E O A; we may obtain these elements in a direct manner if the first characteristic is known, without the necessity of constructing the second curve.

Let us seek the electromotive force and the intensity for a given resistance, R, for a velocity, v_1, the characteristic being constructed for the velocity, v; let K be the relation $\frac{v}{v_1}$, let E and I be the electromotive force and the intensity sought for; we know

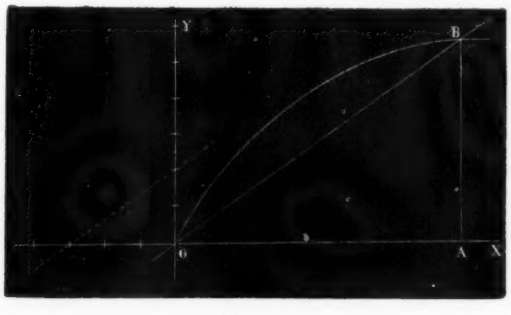


FIG. 7.

that if we call e the electromotive force corresponding to the same intensity for the velocity, v, for the velocity, v_1, we shall have $E = K e$, whence it follows that $I = \frac{K e}{R}$, or again, $\frac{e}{I} = \frac{R}{K}$; that is to say, that on constructing on the characteristic which we possess, a resistance $\frac{R}{K}$, it gives us the intensity I. For this purpose let us divide the axis of y (fig. 7) into parts proportional to the resistances, and the axis of x in the negative direction into parts proportional to the velocities, taking the original velocity as unity, the unity being the same for the two scales; let us measure on the axis, y, the resistance, R, and take upon the axis of x the magnitude, $v_1 = K v$, and join the points thus determined; the line joining them has an inclination, the tangent of which is $\frac{R}{K}$; let us draw from its origin the parallel line, O B, until it meets the characteristic; the magnitude, O A, represents I, and we obtain E by taking A B × K.

We may introduce into the machines a further modification, which consists in changing the coiling, retaining, of course, all the other conditions of the experiment, including the volume of the inductor; let t be the original number of coils of the inductor, and t_1 the new number. The total volume remaining the same, the number of the coils may compensate for the enfeebling of the current in each coil, so that we may have the same excitement and the same magnetic field with the different intensities, I and I_1, provided that we have $t\,I = t_1\,I_1$. Nothing else being changed, an electromotive force, E, which

FIG. 8.

corresponded to an intensity, I, will correspond now to an intensity, $I_1 = I \times \frac{t}{t_1}$; it is therefore sufficient to cause the abscissæ to vary in the same proportion as is indicated in fig. 8, in order to obtain the new characteristic.

If the machine has undergone simultaneously both these modifications, we effect successively both transformations, or we take account in the calculations of the two coefficients to be introduced.

Difference of the Potentials at two points of a Circuit, including between them a given Resistance.

In a circuit of the total resistance, $r + x$, we seek to know what is the difference of potential, e, of two points taken on both sides of the generator, and comprising between them the resistance, r.

Let us take above the axis of x the angle, D O X (fig. 9), such that the tangent, D O X = $r + x$ and the angle C O X, such that tangent C O X = r; the former will represent the total resistance, and the latter the resistance between the given points.

We have:

D A = O A tang. D O A = I ($r + x$)
E A = O A tang. C O A = I r;
D A = E A = D E = I x

or, according to Ohm's law, I x is the difference of potential between the two extremities of the circuit of resistance, x, which

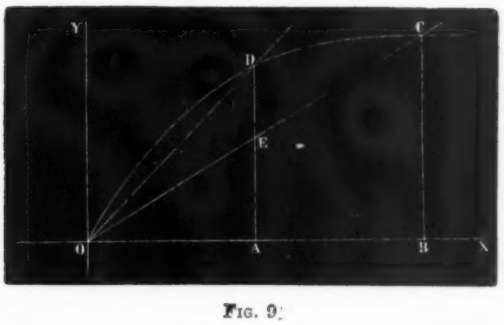


FIG. 9.

forms the complement of the circuit of resistance, r; this is therefore the difference, e, sought for.

Let us suppose, as a particular case, that C O X represents the internal resistance of the machine, and that we cause the total resistance to vary, D E will represent the difference of potential at the extremities of the machine; it will be at first nil when O D coincides with O C; it will then go on increasing, and pass by a maximum to return to zero when the machine "unprimes" itself.

This phenomenon has been observed, and the characteristic permits us to see clearly both its progress and its cause.

Characteristic with an Initial Magnetic Field; its consequences.

Suppose that the inductors carry two distinct circuits formed of wires rolled together, the one at the side of the other, so that the two neighbouring wires may be substantially at the same distance from the core of soft magnetised iron; if two distinct currents pass in the two wires their actions are added together, and the excitement will be the same as if there was passed a single current equal to the sum of the two currents really circulating.

This being assumed let us pass into one of these inductor circuits a constant current coming from an external source; th

resistance of this circuit thus separated from the general circuit will not have to be considered in the total resistance; on the contrary, the second inductor circuit will enter into the general circuit, and will receive the current produced by the machine.

Under these new conditions what becomes of the characteristic?

In all the foregoing investigations it is assumed that we make use of one, and the same constant velocity; the former theorems show what must be done to apply these results to other velocities.

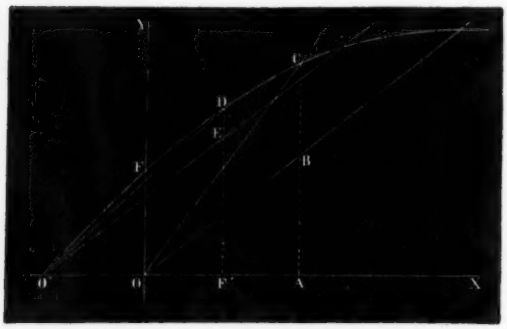


FIG. 10.

Let o' F C (Fig. 10) be the characteristic, obtained as we have done hitherto. Suppose the inductor circuit to be separate, and traversed by a current of the intensity o' o; as the other circuit is as yet inactive, the electromotive force will be o F'; F' will be the point of departure for the new characteristic; the general circuit enters then into activity, and everything goes on as if a current equal to the sum of these two currents traversed a single coil of a volume equal to the bulk of the two actual coils. From this point the characteristic preserves its original form, the modification consisting simply in referring the origin of the coordinates of the point, o', to the point, o; the characteristic setting out from the point, F, the resistances are then calculated as proceeding from the point, o.

A first consequence is immediately perceived. Suppose that in the original condition, *i.e.*, without an external magnetic field, E o' X is the internal resistance of the machine, the maximum difference of potential available will be represented of D E, and will correspond to the resistance, D o' X. With the initial magnetic field the internal resistance being B O X = E o' X, the available difference of potential will increase much as is seen by the line, C B, which does not reach the maximum, but which is much higher than D E.

Rectilinear Characteristic.

If we examine a characteristic we remark that it commences with a portion of very slight curvature up to the moment where we approach the point of saturation of the electro magnets. As far as this point the characteristic may be very well assimilated to a straight line. By employing machines provided with electro magnets of considerable dimensions as compared to the induced, we drive the point of saturation far back, and prolong this rectilinear portion. Doubtless there will be scope to apply this procedure when distribution is effected on a large scale. In the meantime, and as at present constructed, the Gramme machines have been proved experimentally to have a characteristic sufficiently rectilinear for the application of all the following reasonings:

Constant difference of potentials.

If we take the characteristic of a machine for a given speed, we can trace, according to the foregoing considerations, a straight line of a given inclination. If we vary the velocity we must, as

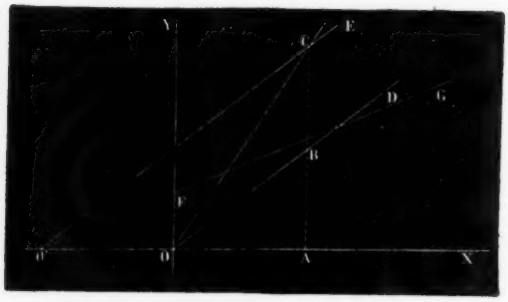


FIG. 11.

has been shown above, multiply all the ordinates by a constant number, which amounts to making the straight characteristic of a certain angle rotate around the point where it meets the axis of x.

This being established, let o' G (fig 11) be the characteristic of a machine. On joining to it a constant external magnetic field the characteristic will be represented by the portion, F G, of the straight line. Let D O X be the internal resistance of the machine, the lines, F G, and O D, meet generally so that the portion of the ordinates comprised between these lines, which, as is known, represents the difference of the potentials at the extremities of the machine, may be variable.

But we have the means of rendering it constant. We can, by modifying the velocity, cause the right line, o' G, to turn round the point, o'.

It is, therefore, possible to bring it to the position, o' C, parallel to O D. Under these conditions, the line, C B, representing the difference of the potentials at the extremities of the machine is constant, whatever may be the total resistance, C O X, given to the circuit.

Distribution by Derivation.

To obtain derivation circuits acting independently of each other, it is sufficient, as we know, to maintain at the extremities of the machine a constant difference of potential, e. Each of the circuits then receives an intensity, $i = e\,r$, which depends merely on its own special resistance, r.

The foregoing theorem has furnished us with the means of obtaining this result without the introduction of mechanical regulators, by the mere play of the electric actions.

We must remark further that the total energy expended remains always equal to the sum of the energies recovered, so that this solution agrees absolutely with the three conditions laid down above.

There is no difficulty in practice. We commence by erecting the characteristic of the machine at a known velocity, v. The coefficient of the inclination of this line is equal to the increase of electromotive force for an intensity equal to unity. On calling E_0 the electromotive force due to the constant external current, it is therefore represented by

$$\frac{E - E_0}{I};$$

let r be the internal resistance, if these two numbers are not equal we seek for a velocity, v', such that we may have

$$\frac{v'}{v} \cdot \frac{E - E_0}{I} = r$$

whence

$$v' = \frac{v\,r}{\frac{E - E_0}{I}}$$

We determine the external excitation according to the constant difference of potential which it is desired to dispose of in the circuit.

When this is done, we place upon each of the poles of the machine a conducting wire which will have the same potential as this pole, and at all the points where we wish to utilise a portion of the energy produced, we join these two conductors by a derivation of suitable resistance.

We may also employ merely a single wire, and cause the return to be made by the earth.

It is evident that by operating thus, especially if the derivations are numerous, we do not preserve the same difference of potential over the whole length of the polar conductors, as the successive derivations tend to decrease it. There is here no especial difficulty; the same case occurs in all possible distributions, such as gas, water, &c., which all lose their initial pressure according as they are expended. It is sufficient to know that we can calculate this loss and know at every point what pressure is available. We can ascertain this with much precision for electricity. This variation, taking place according to a known law, introduces no perturbation in the system.

Distribution in Series.

As we have said, when the recipient apparatus are grasped in series it is not the difference of potential at the ends of the machine which must be maintained constant, but the intensity of the current.

To obtain this result, we excite the electro-magnets by means of a current derived from the principal current.

We must then distinguish in the circuit several portions.

Let I_a be the total current developed in the induced ring.

I_b the derived portion of the current which traverses the inductors and produces the magnetic field.

I_x the portion which traverses the exterior circuit.

a, the resistance of the ring.

b, that of the inductors.

x. that of the external circuit.

Finally, let E be the total electromotive force, and e the difference of potential at the points where the derived inductor circuit separates from the external available circuit.

The intensity, I_x, is that which must be maintained constant in order to distribute the energy to apparatus in series.

We have at first:—

$$I_a = I_b + I_x,$$

which expresses simply that the total current is the sum of its derivations.

On considering the difference of potential at the point of derivation we have :—

$$I_x = \frac{e}{x},$$

and also

$$I_a = \frac{e}{b},$$

whence

$$I_x = \frac{e}{x} + \frac{e}{b}$$

But the total intensity, I_a, has another expression; it is equal to the total electromotive force divided by the total resistance. This is obtained by adding to the resistance, a, of the common part of the circuits, the resistance formed by the sum of the two branches; this is equal, according to a known rule, to the inverse of the sum of the inverses of the resistances, *i.e.*, to $\frac{1}{\frac{1}{b}+\frac{1}{x}}$; the total resistance then will be $a + \frac{1}{\frac{1}{b}+\frac{1}{x}}$, whence we infer

$$I_a = \frac{E}{a + \frac{1}{\frac{1}{b}+\frac{1}{x}}}$$

On equating the two values of I_a we have—

$$\frac{e}{b} + \frac{e}{x} = \frac{E}{a + \frac{1}{\frac{1}{b}+\frac{1}{x}}}$$

$$e\left(\frac{1}{b}+\frac{1}{x}\right) = \frac{E\left(\frac{1}{b}+\frac{1}{x}\right)}{a\left(\frac{1}{b}+\frac{1}{x}\right)+1}$$

$$e - \frac{E}{a\left(\frac{1}{b}+\frac{1}{x}\right)+1} = \frac{E\,b\,x}{a\,(x+b)+b\,x} = \frac{E\,b\,x}{(a+b)\,x+a\,b}$$

Therefore :

$$\frac{E\,b}{e} = \frac{(a+b)\,x + a\,b}{x}$$

or again :

$$\frac{(a+b)\,x + a\,b}{x} = \frac{E}{\frac{e}{b}}$$

$\frac{e}{b}$ is merely I_b and we have finally :

$$\frac{(a+b)\,x + a\,b}{x} = \frac{E}{I_b}$$

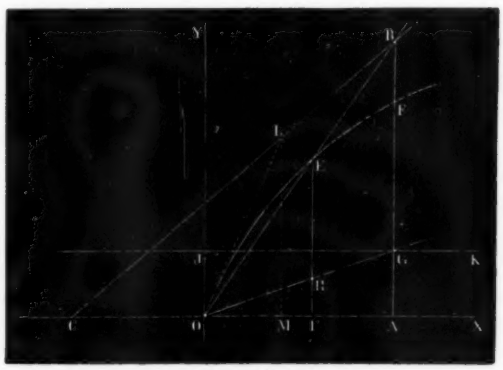


FIG. 12.

This being assumed, let O E F (fig. 12) be the characteristic of the machine, and let us draw the right line, C B, the equation of which is

$$y = (a+b)\,x + a\,b$$

Let us take the length, O A = X, erect the ordinate from the point, A, to the point, B, and draw O B; this line meets the characteristic at a point, E, the ordinate of which is E I. Let us take O J = E and draw the right line, J K, parallel to the axis of X; it meets the ordinate, A B, in G; draw O G, this line meets the ordinate, E I, at H; the length, I H, thus determined represents the intensity, I_x, which was sought. In fact, the similar triangles, O I E O A B, give :

$$\frac{E\,I}{O\,I} = \frac{A\,B}{O\,A} = \frac{y}{x} = \frac{(a+b)\,x + a\,b}{x} = \frac{E}{I_b}$$

Further, according to the very construction of the characteristic, E I is equal to E, and O I to I_b; on the other hand, the similar triangles, O I H, O A B, give

$$\frac{I\,H}{O\,I} = \frac{A\,G}{O\,A}$$

whence

$$\frac{I\,H}{I_b} = \frac{b}{x}$$

therefore

$$I\,H = I_b\,\frac{b}{x} = \frac{e}{b}\,\frac{b}{x} = \frac{e}{x} = I_x,$$

which was to be proved.

(To be continued.)

ELECTRIC PROPULSION.

MR. T. W. RAE, C.E., of New York, sends us a hypothetical estimate for adapting and equipping the elevated railways of New York City for electric propulsion; and of the consequent reduction in running expenses. He says :—The elevated railway system of New York City comprises—inclusive of sidings, &c.—32 miles of track. Upon this road-bed are, or may be, running simultaneously 150 locomotives, each weighing, with its coal, water, and *personnel*, 44,800 pounds, and drawing, at a speed of 13·25 miles per hour, three cars, each weighing, with its seated load of 48 persons and the gateman, 34,230 pounds. Summing up, it amounts to a total weight of 22,123,500 pounds, moved 1,166 feet per minute. Taking the commonly accepted coefficient for resistance to traction in rapport of weight moved, under average conditions of rolling gear and road-bed, to be ·004 (*vide Clark, Holley, Molesworth, Haswell, et al.*), the total work performed by the locomotives in any one minute is 3,127 H.P. nearly.

It is unnecessary to consider grade or curvature in applying the coefficient of tractive resistance, since, of the total number of trains running to and fro, as many will be assisted as retarded by the former; and there being but 12 curves which change direction as much as 90° on all the routes, only 24 of the 150 trains in simultaneous motion could, by any possibility, be passing them at the same instant, and this would not materially affect the total resistance of traction. Further, the influence of curves on the elevated railways is minimised by the admirable method of coupling trains, and it may be added that electric propulsion readily admits of fitting a motor to each car and manipulating them all from one, which would almost entirely neutralise curve resistance.

To make sure that the estimate shall include the most adverse conditions possible, the cars may be considered as crowded to their utmost capacity, or carrying say 100 persons each, and encountering strong side winds. In such a case the coefficient of traction might rise to ·006, and the total work done at any instant would be at the rate of 5,444 H.P. nearly.

The expense of performing this work with steam locomotives may be thus stated :—It requires 227 of them; each costs £6,500, and is served by a driver and stoker, whose combined daily pay is a trifle over £5. Each may also be called upon at any moment to exert some 36 H.P., and the coal required per H.P. may be estimated as follows :—Each engine burns 40 lbs. per mile run, in the ordinary routine service of drawing trains, and the average speed per hour, inclusive of stops, is 12·5 miles. This is a consumption per engine of 500 lbs. per hour. The quantities hitherto dealt with have been maxima, and it will be necessary to modify them to get a fair average consumption of fuel per H.P. developed. The weight of locomotive and the number of cars per train remain unchanged, but the feet moved through per minute are reduced to 1,100,

and, assuming a load of 25 persons per car as a reasonable mean between running crowded morning and evening, half full in the middle of the day, and nearly empty at night, the load moved may be taken at 136,690 lbs. Applying the general coefficient of traction, ·004, this becomes 547 lbs. moved 1,100 feet per minute, or 18 H.P., at a cost of nearly 28 lbs. of coal per H.P. per hour. Of course, it is almost impossible that each engine should burn this quantity for each actual H.P. of work it performs. The warming of trains is included in it, and the average is no doubt vastly increased by the number of reserve engines which must be kept standing with banked fires ready for immediate service. The cause is not any unusual inefficiency of particular locomotives—although at best, they are four times more wasteful performers of work than large stationary engines of the best type—but it is one inseparable from the system of subdivision of locomotive power, and it is therefore correct to say that, in such a system, a H.P. costs 28 lbs. of coal.

The statement will then be, taking an hour as the unit of time :—

Interest upon and depreciation of 227 locomotives at $6,500, at the rate of 15 per cent. per annum ...	$25·26
Wages of attendants for 227 locomotives	47·30
Total coal at $3 per ton for 150 locomotives, developing 18 H.P. each, at 28 lb. per H.P.	102·00
Total per hour	$174·56

To do the same work electrically would require the following named equipment :—

It is quite possible to obtain dynamos which will return at any ordinary distance 75 per cent. of a H.P., developed by steam engines at the generating station, and this can readily be had for two pounds of coal per hour from large improved constructions. But assuming 50 per cent., or thereabout, to be the ultimate and a duplicate installation to be superfluous—which latter assumption is in accord with expert opinion—the items will be :

6 Stationary steam engines, 1,800 H.P. each, with boilers, costing inclusive of erection	$270,000
8 Generating dynamos, each 1,350 H.P. capacity, inclusive of erection	273,375
1 Station house at East One Hundred and Twenty-ninth Street for the Second and Third Avenue lines	20,000
1 Ditto at battery for the Sixth and Ninth Avenue lines	30,000
227 electro-motors at $3,000	681,000
32 miles central rail, 35 lb. per yard, laid	40,000
Total	$1,314,375

This amount would in all likelihood be largely modified by the sale of the steam locomotives—which are of standard gauge—for use in short surface railways ; but letting this probable rebate stand as an offset to unforeseen contingencies, the statement of current expense of electrical motive power and concomitant plant will be, taking an hour as the unit of time :

Interest upon and depreciation of installation at 10 per cent. per annum	$15·00
Total coal at 2 lb. per H.P. and $3 per ton	28·93
Labour at power-stations, 2 chief and four assistant engineers at $22 per diem, 40 stokers at $80 per diem	4·25
Wages of 1 attendant per motor, 227 at $3 per diem.	28·38
Total per hour	$70·56

NOTE.—It should be explained *en passant* that the lower rate per cent. for depreciation of electrical machinery is based on superior durability due to its simplicity, few parts, and the absence of reciprocating movement.

This amount is the total current cost of the maximum work done in any one hour upon all the lines. In comparison with the same quantity obtained through steam locomotives, the ratio is about as 1 to 2·28. In other words, electricity will perform for $1 the indentical work for which steam charges $2·28.

Surprising as the result is, it does not embrace various advantages to which it is impossible to affix a quantitative value, such as reduced wear of road-bed by the great diminution of weight in the tractors. Some idea of this may be had by reflecting that the average adhesion to the rails of an electro-motor is—by reason of some molecular change in the contiguous surfaces of wheel and rail caused by the current circulating through them—about 40 per cent. of its weight as compared with 20 per cent. in the steam locomotive. That is to say, an electro-motor of half the weight of a steam locomotive will haul the same load. The absence of smoke, exhaust steam, noise, and cinders dropping to the streets, is also of incalculable advantage in a city service.

Whether the conclusion arrived at be modified or not—it cannot be nullified—by further investigation, the indications are sufficiently clear to warrant stockholders of the elevated railways of New York City in demanding of their several boards of direction an immediate and thorough examination of electric propulsion, aand its earliest practicable adoption if its claims are substantiated,

AN "EARTH ALARUM" FOR ELECTRIC CIRCUITS.

THE accompanying diagrams illustrate an apparatus for giving an alarm when any portion of an electric lighting circuit is earthed by accident or design.

Fig. 1 shows a front view and fig. 2 an end view of the apparatus, which is now being introduced by Messrs. Mather & Platt, of Manchester. Upon the base, H, there are mounted an electric bell, of which G is the gong and B the coils, a switch, A, K, for cutting

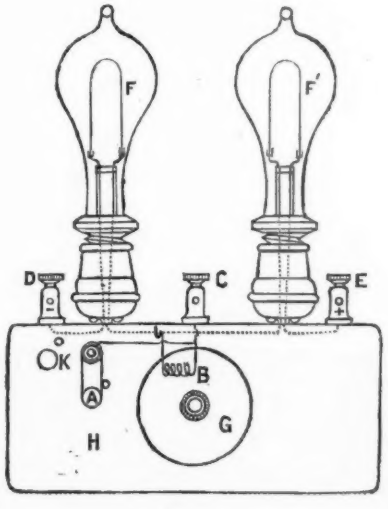


FIG. 1.

the bell out of circuit, three terminals, E, C, D, and two incandescent lamps, F, F¹. The leading wire of the circuit is connected to E and the return wire to D at any convenient station or position. The circuit is then completed, so far as this particular derivation is concerned, through D, F¹, F, E, and the lamps will be lighted. These lamps are the same as those employed in single derivation on other parts of the circuit for lighting. Thus, if the electromotive force of the current is 100 volts, the lamps, F and F¹, are each lamps requiring that electromotive force ; and it follows that, as they are in series, each will receive much less than half the current necessary for full light, because it will not become hot, and by that means have its resistance reduced. The light, then, from each lamp will be considerably less than one-quarter full power, and barely more than a visible glow when all is well. If a wire is connected to C by one of its ends, and by its

other end to a good "earth," then, since C is connected to the circuit at J, it will happen that if there is an earth elsewhere on any portion of the line the bell will ring, and one of the lamps will attain its full intensity, or somewhat less. Not only this, but the conductor on which the fault has arisen is indicated by the lamp, which becomes bright. Thus if F brightens upon the ringing of the bell, it is because the current is deviated

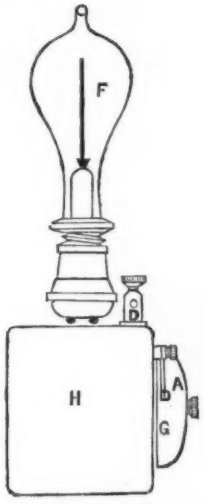


FIG. 2.

through C, and the resistance of F^1 is cut out of the derivation, D, E, F, F^1, included in the apparatus. Hence the defect will in this case be in the return conductor attached to D. To avoid the continuous ringing of the bell after the alarm has been given, the switch handle, A, is turned into contact with K, when the bell coils will be but put into a derivation of so high comparative resistance as to be inoperative.—*The Mechanical World.*

RECENT PROGRESS IN DYNAMO-ELECTRIC MACHINES.*

By Prof. SILVANUS P. THOMPSON.

(*Continued from page* 220.)

The Edison dynamo has, during the past eighteen months, received very material improvements at the hands of Dr. Hopkinson, F.R.S. Some of these improvements relate to the field-magnet; others to the armature. Dr. Hopkinson has, in the first place, abolished the use of the multiple field-magnets, which in the Edison "L" "K" and "E" machines were united to common pole-pieces, and instead of using two, three, or more round pillars of iron, each separately wound, he puts an equal mass of iron into one single solid piece of much greater area of cross-section and somewhat shorter length. One such iron mass, usually oval or oblong cross-section, is attached solidly to each pole-piece, and the two are united at the top by a still heavier yoke of iron. The machines have, consequently, a more squat and compact appearance than before. It may be remarked, in passing, that the use of multiple pillars of iron used by Edison in the "L," "K," and "E" machines must have been prejudicial, because the currents in those portions of the coils which passed between two adjacent iron pillars must have been opposing each other's magnetising effect. Dr. Hopkinson has also introduced the improvement of winding the magnets with a copper wire of square section, wrapped in insulated tape. This wire packs more closely round the iron cores than an ordinary round wire. In the armature the following change has been made. The iron core in the older Edison machines was made of thin iron discs, separated by paper slipped on over a sleeve of *lignum vitæ*; and held together by six longitudinal bolts passing through holes in the core-plates, and secured by nuts to end plates. These bolts are now removed, and the plates are held together by great washers, running upon screws cut on the axle of the armature. The size of the central hole in the plates has been diminished, thus getting into the interior more iron, and providing a greater cross-section for the magnetic induction. By these improvements, a machine occupying the same ground space, and of about the same weight as one of the older "L" 150-light machines, is able to supply 250 lights, the efficiency being at the same time improved. In the new 250-light machine, the diameter of the armature is 10 inches; its resistance, cold, is 0·02 ohm; that of the magnets is 17 ohms. The characteristic curve of the machine shows that even when doing full duty, the field-magnets are far from being saturated. It will be remarked that, in the older construction, the bolts and their attached end-plates furnished a circuit in which idle currents were constantly running wastefully round, with consequent heating and loss. An Edison 60-light "Z" machine of the older pattern, tested by the committee of the Munich Exhibition, was found to give an efficiency which, if measured by the ratio of external electric work to total electric work, exceeded 87 per cent.; but its commercial efficiency—the ratio of external electric work to the mechanical energy imparted at the belt—was only, at the most, 58·7 per cent. In a recent test* made by Mr. Sprague, at Manchester, on an improved dynamo (a 200-light machine), the efficiency of electrical conversion exceeded 94 per cent., and the commercial efficiency 85 per cent.†

The Siemens machines have not been much altered during the past year; and it is a little difficult to describe the improvements which have been made, as the firm of Siemens Bros. decline, for commercial reasons, to furnish data for publication. Progress has, however, been made by this firm, especially with their compound-wound machines, of which some account has been given by Herr E. Richter, in the *Electrotechnische Zeitschrift*. It appears that three methods of combination have been tried. The shunt and series coils have been wound on different arms of the magnets; they have been wound on separate short frames, and slipped on to the cores side by side; and they have been also wound over one another. In the latest machines, the series coils are wound outside the shunt windings. The regulation, judging by the curves given by Herr Richter, is not perfect. The best regulation was from a "*g* D 17" machine, of which two of the magnet limbs were wound with shunt coils of 29 layers of a 1 millimetre wire, and the other two with two layers of a 3·5 millimetre wire. The potential varied from 64 to 69 volts when the number of lamps was reduced from 20 to 9.

The Weston machine has an armature more or less resembling those of the Siemens machines. The core is built up of discs of iron, strung together, and presenting projecting teeth all along the surface of the cylinder. In this machine the pole pieces are laminated, to obviate eddy currents and heating. Recently, Mr. Weston has adopted a method of winding the armature with two circuits, so that an accident to one section shall not completely break down the machine. The latest of the Weston machines show substantial design, and many improvements in detail upon the older forms.

The machines of the Gramme type next come in for consideration. In those of the actual Gramme pattern I cannot learn that any important improvement has been made in this country; but in the States, the Fuller Electrical Company, which holds the Gramme and Wood patents, has brought out several improved forms of machine, in which mechanical engineering skill of a high order is apparent. The field-magnets, frames, and pole-pieces are very substantial, the ring is better built than the European types, and the collector bars are prevented from flying to pieces by the addition of an insulated ring shrunk on over their ends. In France, too, the machine has received important modifications at the hands of M. Marcel Deprez. M. Deprez's dynamo has two Gramme rings upon one axle, which lies between the poles of two opposing field magnets, each of the two-branched, or so-called horseshoe form. These are laid horizontally, so that the north pole of one is opposite the south pole of the other, and *vice versâ*; the poles being provided with curved pole-pieces between which the rings revolve. M. Deprez, who has given much attention to the question how to design a machine which, with the least expenditure of electric energy, gives the greatest actual couple at the axle, is of opinion that the horseshoe form of electro-magnet is the most advantageous. The iron cores and yokes of the field-magnets are very substantial; but the pole-pieces are not very heavy. M. Deprez's machine has a very elaborate system of sectional windings of the field-magnets and a switch-board, enabling him to couple up the connections in various ways. The circuits of the two rings are quite distinct, and each armature has its own collector and brushes. M. Deprez has also constructed other Gramme machines, with armatures of very fine wire, for his experiments on the electric transmission of power.

Another machine, having as an armature an elongated ring somewhat like that of the Maxim dynamo, was shown during last autumn at the Fisheries Exhibition, under the name of the Hockhausen dynamo. The field-magnets of this machine are very strangely disposed, the ring being placed between two straight electro-magnets placed vertically over one another; the upper magnet being held in its place by curved flanking-pieces of iron, which run down the two sides of the machine, and connect the topmost point of the upper magnet with the lowest part of the lower. This arrangement, which strikes the eye as being both mechanically and magnetically bad, is claimed as one of the virtues of the machine, which, in spite of its magnets, appears to be a very good working machine. Its armature is constructed of

* Paper read before the Society of Arts, Feb. 28th, 1884.

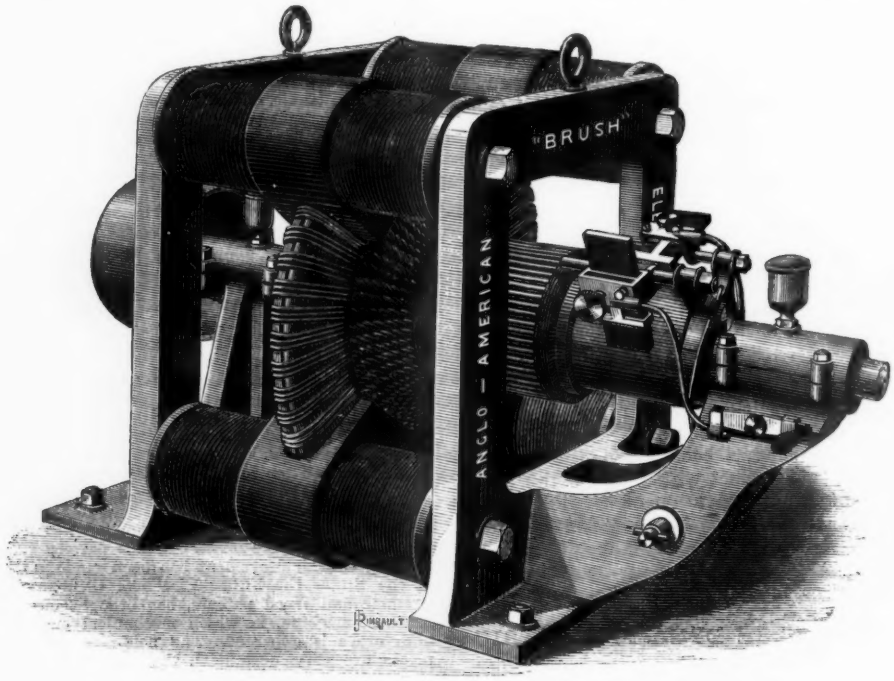
* See ELECTRICAL REVIEW for September 15th, 1883.

† These values assume the B. A. unit as the true ohm, and are, therefore, probably about 1½ per cent. too high.

four separate curved iron frames, upon which the previously wound coils are slipped, and which are then bolted together and secured to strong end-plates. I have not seen any report on the efficiency of this machine.

We next come to the class of machines in which a flattened Gramme ring is used, and of which the machines of Fein, Schuckert, and Gülcher are the best known types.

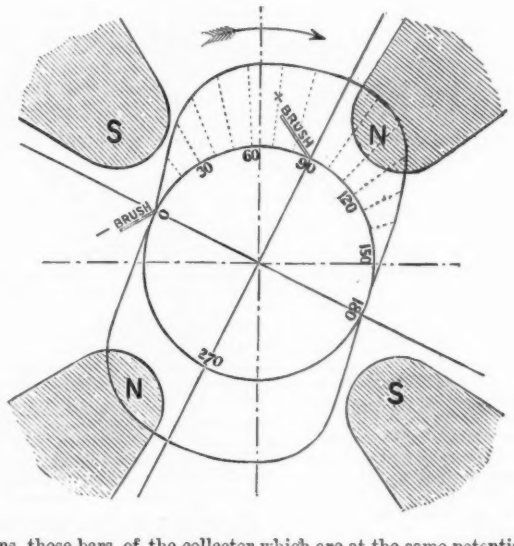
Mr. Gülcher has been steadily at work improving his dynamo in its various mechanical and electrical details. In particular, he has devoted attention to the winding of the field-magnets, so as to secure a constant potential at the terminals. After experimenting with various methods of compounding, he finds that the best results are arrived at in the following way:—In his four-pole dynamo there are eight cores to be wound. Each of these receives a shunt coil of fine wire, and outside this a main coil of stout wire. The eight fine wire coils are then joined up in series with one another, and connected as a shunt to the terminals; whilst the eight main circuit coils are joined up in parallel. In proof of the degree of accuracy attained by this method, Mr. Gülcher has given me many numerical data from actual tests. All of them show a very fair approximation to a constant potential, and an actually attained constancy for a considerable range.



VICTORIA (SCHUCKERT-MORDEY) DYNAMO (4-POLE).

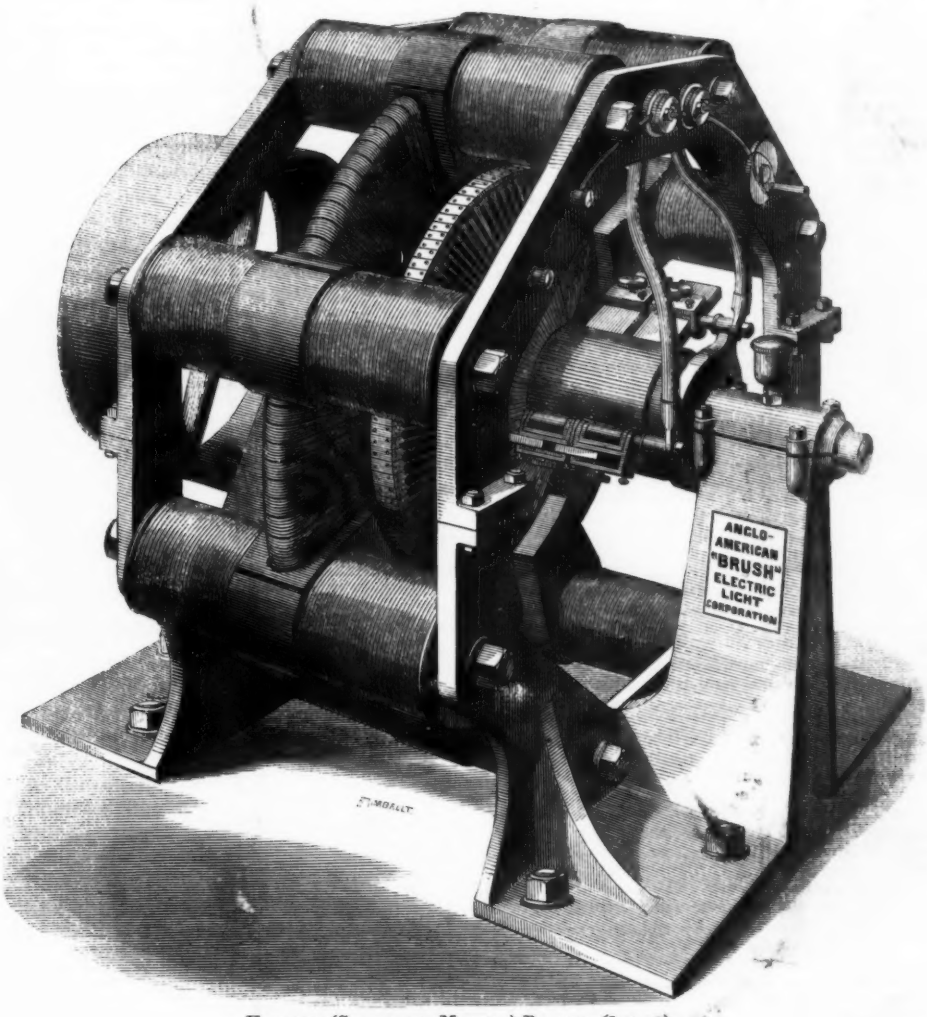
For example, a 4-pole machine, intended to give 65 volts, gave that figure exactly, when the external current varied from 30 to 88 ampères, and 63·5 volts at 130 ampères. With one ampère only, the potential was 61·5 volts. Mr. Gülcher adds that, in spite of all possible care in manufacture, very large machines do not give results as satisfactory as those given by machines of somewhat smaller dimensions, though the machines are of identical type, and their parts calculated from the same formulæ. He thinks this to indicate that to obtain the same ratio of out-put and efficiency to weight, there ought to be a corresponding increase made in the electromotive force of the machine. In other words, the means taken in large machines to keep down the electromotive force to equality with that of the smaller machines are detrimental to the action of the machine.

The Anglo-American Electric Light Corporation has been manufacturing during the past year a dynamo of the flat-ring type, under the patents of Schuckert and Mordey, to which the not very apt name of the "Victoria" dynamo has been given. There are two types of the new Schuckert-Mordey dynamo, one having four, the other eight poles arranged round the ring. As mentioned earlier in this paper, Mr. Mordey has given great attention to the form of the pole-pieces. These pole-pieces, in the earlier Schuckert machines, consisted of hollow iron shoes or cases which occupied a large angular breadth along the circumference of the ring. Similar hollow polar extensions are still used in the Gülcher machines. Mr. Mordey has found my opinion, based upon the diagrams of potential at the collector, to be correct, that these wide-embracing pole-pieces were responsible for false inductions, giving rise to opposing electromotive forces and setting up secondary neutral points at the collectors. He has, therefore, by long extended experiments, arrived at a form of pole-piece which completely obviates these effects. In the 4-pole Victoria dynamo, the pole-pieces, though they embrace the ring through its whole depth, from external to internal periphery, are quite narrow, and do not cover more than 30° of angular breadth of the circumference of the armature. They are of cast iron, and are cast upon the cylindrical cores of soft wrought iron, which receive the coils. It may be mentioned that, in the 4-pole Gülcher machines, the wide box-like pole-pieces are also cast on wrought iron cores. The armature of the Victoria dynamo resembles in its structure the Pacinotti rather than that of the Gramme type. Its core is built up of rings cut from sheet charcoal iron, and Mr. Mordey has taken special pains to ensure that there are no electric circuits made in the bolting together of these cores, each plate being both electrically and magnetically insulated from the adjacent plates. Eddy currents in the core are thus almost entirely obviated. This was far from being the case with some of the earlier machines, in which, as in the Edison machine until Dr. Hopkinson improved it, the bolts holding together the cores constituted an available path for wasteful inductions. The core rings of the Victoria dynamo are toothed, as in the Pacinotti ring, and the wires are wound in the intervening gaps. There is, moreover, ample ventilation in this armature, a point not to be overlooked. Formerly, in a 4-pole machine, four brushes were necessary—as in the Gülcher dynamo and the 4-pole Gramme. Mr. Mordey has reduced the number to two, by the device, firstly, of connecting together those segments of the armature coils which occupy similar positions with respect to the poles; and, secondly, of connecting together, by metallic connections, those bars of the collector which are at the same potential. In the 4-pole machine opposite bars are thus connected. Two



brushes only are then necessary, and these are 90° apart. The figure here shown gives the actual diagram of the potentials at the collector. There being 60 sections in the ring, there will be 15 segments of the collector from the negative brush to the positive. The potential rises steadily from the negative brush, and becomes a maximum at the positive brush, at 90°, whence it again diminishes to zero at 180°. The bars of the collector being connected, it will be remembered, to those diametrically opposite to them, it follows that the potential will rise from 180° to 270°, precisely as it rose from 0° to 90°, and will again fall to zero in passing from 270° to 0°. If the curve from 0° to 180° were plotted again horizontally, we should clearly see how nearly regular the rise and fall is. If from this curve we were to construct another one, in which the heights of the ordinates should correspond to the tangent of the angle of slope of this potential curve—in other words, if we were to differentiate the curve—we should obtain a second curve—the curve of induction. It would show a positive maximum at about 30°, and a negative maximum at about 120°, where the slope up and slope down are steepest in the potential curve. These maxima of induction are situated very nearly opposite the edges of the pole-pieces, on the side toward which the armature is rotating. Apparently the lines of force of the field are the thickest here. In this displacement of the maximum of induction we have, I think, the explanation of the inferiority of the earlier machines with broad polar expansions. In those machines the maximum position of induction was displaced to the very edge of the broad pole-piece, and, therefore, the induction was sudden and irregular. It is a singular result that while in those machines in which the ring armature is extended cylinder-wise, there must be wide-embracing pole-pieces, in those in which the ring is flattened into a disc shape, the pole-pieces must on no account be wide.

The Victoria dynamo is self-regulating, having all the eight field-magnet coils doubly wound, with main circuit coils inside, and shunt coils outside. The characteristic of this machine is wonderfully straight. In a "D²" machine, wound for a potential of 60 volts, the following values were obtained. Open circuit, 58 volts; 10 ampères, 58·5 volts; 20 ampères, 59 volts; 60 ampères, 59·7 volts; 90 ampères, 59·9 volts; 120 ampères, 60 volts. It will be seen that for small loads the potential drops a little; but it is under these circumstances that the engine speed usually rises slightly in practice, so that the constancy of the potential between the mains is somewhat better than the figures would show. In actual practice, the regulation is marvellous. I have myself opened the circuit of a Victoria dynamo which at the time was feeding 101 lamps, 100 being at a distance, 1 lamp attached to the terminals of the machine. On detaching the main wire from the terminal, the 100 lamps were suddenly extinguished. The solitary lamp on the machine did not even wink, and there was no flash at the brushes. The sparking was so slight it was impossible to tell whether the machine was an open circuit or whether it was doing full work. The lead was the same under all loads. There are not many dynamos that can show a result of this kind. According to measurements made by the Anglo-American Corporation's electricians, who have published the figures entire, the factor of conversion of this machine is 96·15 per cent., the electrical efficiency 85·68 per cent. These values assume the B.A. unit of resistance as the true ohm, and are, therefore, probably about 1½ per cent. too high. Some of these machines are wound for low speeds for ship lighting. These machines have an electrical activity slightly higher, and an efficiency slightly lower, than the high speed machines. They also have field-magnet cores slightly heavier, requiring, therefore, the expenditure of rather more electrical energy in maintaining the field. These remarks refer, of course, to a comparison between machines wound to light an equal number of lamps, and to work at an equal electromotive force.



VICTORIA (SCHUCKERT-MORDEY) DYNAMO (8-POLE).

A larger type of Victoria machine having 8 poles, alternately north and south, set round the ring, has also been constructed by the Anglo-American Corporation. This machine illuminates 750 incandescent lamps. The ring has 120 sections, there being 15 sections, therefore, between each pole and the adjacent pole of the surrounding set. As each segment of the collector is connected with those situated at 90°, 180°, and 270° distance round the set, only two brushes are required.

A rather singular commentary upon the real superiority of multipolar dynamos having rings of the flattened type, over the more compact ring armatures to which we have been accustomed in the ordinary Gramme machine, is furnished by the announcement within the past month of a new and improved dynamo

designed by M. Gramme himself, in which there is a flat-ring armature rotating within a crown of 12 poles. Elaborate illustrations and a detailed description of this latest of dynamos are given in the *Revue Industrielle*, of January 9th, 1884. From this article it appears that in the opinion of M. Gramme the new machine still requires some modifications to make it quite a practical machine. A glance at this drawing is quite sufficient to enable one to hazard a guess at the reasons. The pole-pieces are broad, nearly meeting one another. I should confidently predict from such a design the vice of sparking at the brushes and heating of the collector segments. Moreover, there are no fewer than 24 brushes! Think of the friction of 24 brushes, and the labour of making the complicated holders. It appears that in England we are at least a few steps ahead of France in the matter of designing dynamo-machines.

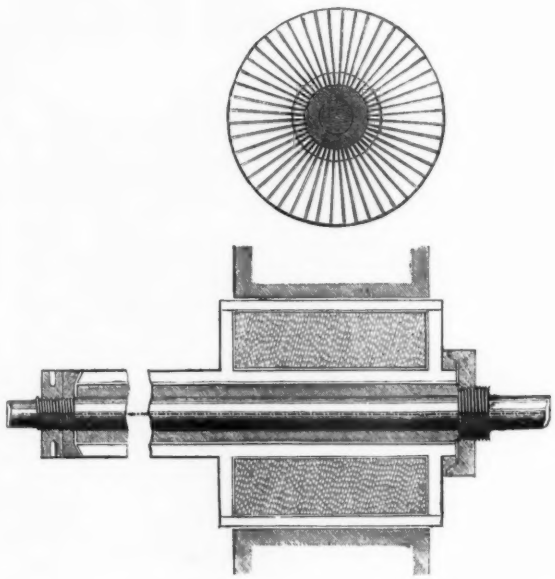
Another 4-pole flat-ring dynamo has been designed by Herr Schuckert, of Nürnberg, and was exhibited at the late Vienna Exhibition. This machine, which had many excellent points in its design, was compound wound, and was calculated to give, at 450 revolutions, a current of 320 ampères at 100 volts.

The present drift toward multipolar dynamos of this type is very significant. There is little difference save in detail between the 4-pole machines of Gülcher, Schuckert, and the newer "Schuckert-Mordey" dynamo, albeit these differences are not unimportant. But all these constructors agree in adopting the flat-ring. The advantage originally claimed for this construction, namely, that it allows less of the total length of wire to remain "idle" on the inner side of the ring, is rather imaginary than real, for the total resistance of the armature is but a small fraction of the whole resistance of the circuit; and it is possible to spread the field so as to make all parts of the wire active without any gain whatever, if, by this spreading, there is no increase on the whole in the total number of lines of force in the field. The real reasons in favour of multipolar flat-ring armatures appear to be the following:—First, their excellent ventilation; second, their freedom from liability to be injured by the flying out of the coils by the tangential inertia (often miscalled centrifugal force) at high speeds; third, their low resistance, due to the fact that the separate sections are cross-connected either at the brushes, or in the ring itself, in parallel arc. To these may be added that, with an equal peripheral speed, the armature rotating between four poles undergoes twice as much induction as when rotating between two poles; since it cuts the lines of force twice as many times in the former case as in the latter.

I pass on to the improvements made in the dynamo by Messrs. R. E. Crompton & Co. The armature of the original machine, as it came from Switzerland, consisted of several rings set side by side on one spindle, these rings being made of iron wire wound upon a square frame, and carrying each four coils. In this form it is described in Professor Adams's Cantor Lectures on "Electric Lighting" in 1881. Mr. Crompton changed the square form to a hexagon having six coils upon it, and increased the number of rings to ten, so that the armature consisted of sixty segments. He then found it advisable to alternate the positions of these, instead of placing them in a regular screw-order on the spindle as shown in most of the published drawings of this well-known machine. The next step was to increase the quantity of iron in the hexagonal cores, and to ascertain by experiment what was the best relative proportion of iron and copper to employ. At the same time, Mr. Crompton and Mr. Kapp introduced their system of "compounding" the windings of the field-magnets. Another change in the armature followed, the rings being made much broader and fewer in number, four massive hexagonal rings, united to a 24-part collector, replacing the ten slighter rings and their 60-part collector. Quite recently Mr. Crompton and Mr. Kapp have again remodelled the style of armature, and have produced a machine which, though it is not yet quite completed, shows what may be done in the way of improvement by careful attention to the best proportions of parts and quality of material. The new dynamo weighs 22 cwts. Its field-magnets are of the very softest Swedish wrought iron, compound-wound. The armature is a single ring of the elongated or cylindrical pattern, and its coils are wound upon an iron core made up of toothed discs of very thin soft iron fixed upon a central spindle, the coil being wound between the teeth as in a Pacinotti ring. In fact, the armature may be described as a kind of cross between those of Weston and Pacinotti, having also something in common with the Burgin armature; at least, so I understand, for though I have, by the kindness of Mr. Crompton, been allowed to see the machine, I have had no opportunity as yet of examining the armature. Mr. Crompton's great aim has been to have as complete a magnetic circuit as possible, and that of the best quality. He has sought to increase the intensity of the field by having plenty of iron in the armature, and bringing that iron as close as possible into proximity with the pole-pieces by means of the projecting teeth. The result is an extraordinary increase in the "output," or, as Sir William Thomson terms it, "activity" (*i.e.*, amount of work done per second) of the machine. The machine is only 3 feet 4 inches long, 12 inches high, and 2 feet wide. The armature is 17 inches long, and 8 inches diameter. At 1,000 revolutions per minute it gives 110 amperes at 145 volts, or its "activity" is 15,950 watts; but at this speed it heats too much. The power of the field-magnets is such that, at all speeds, and under all conditions of the external circuit, the intensity of the field overmasters the magnetising action of the currents in the armature coils. There is, therefore, hardly any lead at all at the brushes, and what lead there is is absolutely constant. There is no sparking at the brushes, and it is impossible to tell by looking at the brushes whether the current is off or on. Mr. Crompton is now constructing another machine of the same general design, but larger, to drive 1,000 Swan lamps. This machine, together with its engine, is only about 8 feet long, 6 feet high, 2 feet 4 inches wide, and complete, with its bed-plate, will weigh only about 8 tons.

It may be mentioned that in Messrs. Crompton's compound dynamos, as also in those of the Anglo-American Corporation, the series coils are wound direct upon the iron cores, and the shunt coils outside them, thus reversing the practice adopted by Messrs. Siemens and by Mr. Gülcher. It might have been expected that theory would have something to say in determining which practice is preferable. If the shunt coils of thin wire are outside, the prime cost for an equal magnetising effect will probably be greater. If the series coils are outside, the loss by heating in producing an equal magnetic effect will probably be increased. It might have been expected that, as with galvanometer coils, so with the coils of field-magnets, it would be advantageous to get as many of the turns as close as possible to the core, and, therefore, that the thinner wire should be wound on before the thicker. But, on the other hand, it is advisable to keep down the resistance of the series coils, as they will form part of the main circuit; whilst the additional resistance necessitated by winding in coils of larger diameter is not altogether a disadvantage in a shunt coil. If this proves to be the right way of regarding the problem, we shall wind the shunt coils outside those that are in series with the main circuit.

Before leaving the subject of ring armatures I should like to refer to a form recently devised by Signor B. Cabella,* which



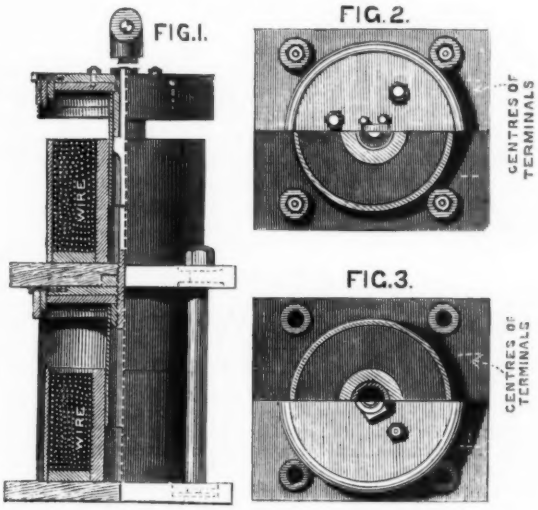
I think might be recommended to amateur constructors of dynamos as being easily made. The figures show its general arrangements. The armature resembles that of the Edison dynamo in being built up of copper strips. These are separately cut out, and consist each of a straight piece having two arms, and projecting at right angles. A sleeve of insulating material is placed over the axle, and round this these copper pieces are arranged to the number of some 240 or so, having their arms projecting symmetrically round in two radial sets, one near one end and the other near the other. The channel formed thus between the two sets is lined with insulating material, and then entirely filled up with soft iron wire wound round. Then straight strips of copper, eight millimetres broad and two millimetres thick are screwed across the outside (like the bars of the Edison armature) from the ends of one set of radial projections to the ends of the others, forming the parallelogram section. But, in order to connect the ring all round in a continuous circuit, these external strips of copper are connected at their two ends to pieces which project not from the same internal copper strip but from adjacent strips. Thus an external bar will connect the anterior end of the first strip with the posterior end of the second; and so on. Every third strip is carried along the axle and connected to a segment of the collector. This construction is certainly simpler than that of the Edison armature, and might be adapted to many different types of machines. According to Professor Ferrini, one of Cabella's armatures placed between the poles of a 60-light Edison ("Z," old pattern) instead of its ordinary armature, increased its power so that it could be used over 100 lamps.

(To be continued.)

* For view of this machine see ELECTRICAL REVIEW for August 18th, 1883.

ELECTRIC RAILWAY SIGNALS.

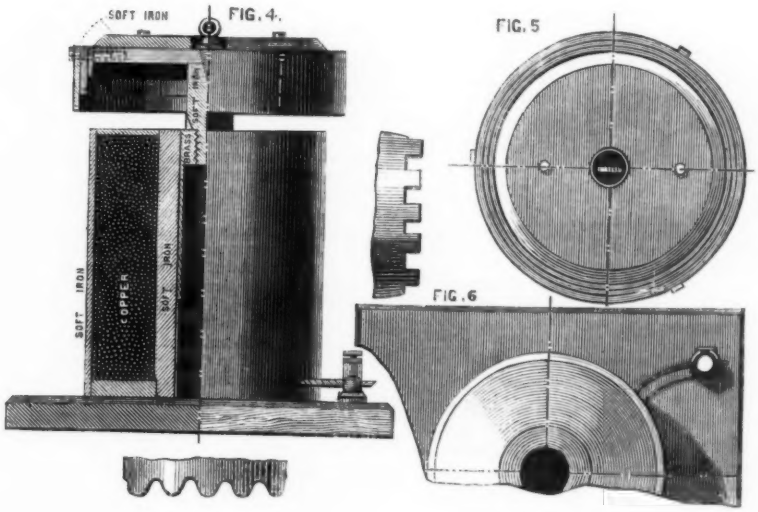
A SYSTEM of electric railway signalling has been devised by Messrs. Stanley Currie & Illius A. Timmis, and carried out under them by the Gloucester Waggon Works Company. Primarily the value of the system is, that it enables signals to be worked at any distance from a signal-box or station; but several other important collateral advantages are obtained, including great facility of arrangement of large signal plant, simplicity of the working apparatus and the arrangement, and for interlocking and the immunity from danger, secured by the fact that any disarrangement of any part of the apparatus or connections causes the signal to fly to danger.



In the apparatus employed the essential element is Mr. Currie's long-pull magnet, which was described in our columns for March 8th.

a central core, the lower part of which is covered by a brass tube. At the top of the brass tube the core is made conical for a short distance, and above this it supports a soft iron disc, with a flanged periphery, of the section shown at fig. 4. The outer part of this flange is adjustable as to the amount by which it projects downwards from the disc, and it is, moreover, in some cases made with a serrated or wave-formed edge, as shown near figs. 4 and 6, the object and the result of this being that the pull by the magnet is not suddenly increased as the disc nears the magnet head. It will be seen that the magnet and the short core act as a solenoid, until the core has entered a considerable distance into the tube. This gives the first part of the pull; and as the strength of the pull on the core is decreasing, owing to the core having reached the position of greatest solenoid effect, the disc head itself is nearing the magnet head, and the pull on it consequently increasing. Hence the approximately equal pull through a considerable range. The sudden contact by a violently strong pull, which is common to ordinary magnets when the armature reaches the magnet, is avoided by the form of the disc periphery. Figs. 1 to 3 show the magnet as arranged in pairs, to obtain a double length of pull, as required, for working signals, when the semaphore is required to stand at the three positions of line clear, caution, and danger. When the armature of the upper of the pair of magnets has reached its lowest point, the armature of the lower magnet has reached a position in which it has just begun to act, the spindle connecting the two being free to slide within the core of the upper armature.

As applied to a signal, with the semaphore balanced at mid-length as on the Great Northern Railway, says our contemporary, a box containing the magnet is at the side of the post opposite to that carrying the arm and spectacle. The spectacle forms the balance weight, or rather weight by which the semaphore is held at "danger," when the electric circuit is broken and the magnet not acting; the rod between spectacle and semaphore is jointed to spectacle, so that when the spectacle is down, showing danger, its pivot or spindle, and the rod joint upon it, are in line with the rod, and consequently the semaphore is locked in that position against any forces other than the pull of the magnet upon its quadrant at the other end of the spectacle plate.



This magnet we illustrate in two forms by figs. 1 to 6, reproduced from the *Engineer*. From these it will be seen that the single magnet, figs. 4, 5, and 6, consists of a central soft iron tube, the lower end of which is attached to a soft iron plate, which at its periphery supports a larger soft iron tube, the annular space between the two being filled with wire of various sizes, generally ·048. A brass plate covers the upper part of the magnet so made. The armature consists of

In the Gloucester Waggon Company's Works, three point levers of the usual kind are shown, and 10 signal levers by the new system, with the accompanying electrical instruments.

Within the signal-box at Gloucester, the switch levers, numbered 1 to 6, were coupled up, the remaining four were not. Levers 1, 2, and 6 were forward, and the corresponding lamps were incandescent. In Fig. 7 these small switch levers are shown to a larger scale,

and the Swan lamps used as resistances are shown attached near the lever instead of above the levers, as was actually the case in the signal-box. It will be seen that when the lever, Y, is in the position, Z, the contact piece, C, is not touching L, so that the current now going to the signal magnet must pass through the lamp into L. Only a very small current is thus passing, this being the position of the lever when the armature is upon the magnet. When the lever is in the position, X, the semaphore stands at danger. When the lever is pulled over to the position, Z^1, the contact piece, C, being in contact with L, the full current passes to the signal magnet. This is required to start the magnet and pull the semaphore down. This is done momentarily, and the lever will not remain in this position unless purposely held, because the spring, S, pressing against the quadrant, R, causes the lever to take the position, Z. The quadrant and spring also come into play when the handle is pushed beyond X. The Swan lamps not only act as resistances, but they show the signalman when the current is passing and all is working properly. When the armature of the magnet is pulled "home," and the signal is "free"—*i.e.*, "line clear"—a contact switches on a small return resistance wire—between the magnet and the rail conveying the return current—which works a small magnet and tell-tale signal or "repeater" in the signal-box, and thus tells the signalman the position of the semaphore. The small resistance wire which takes up the return current, instead of allowing it to go directly through the rail, reduces the amount of current passing through the magnet from 5 ampères to ·125 ampères, and thus economises the

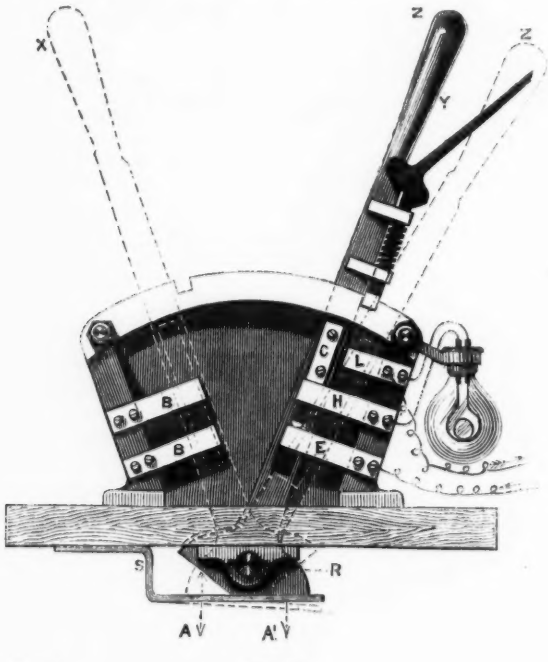


FIG. 7.

electric current. A current of ·125 ampères is more than sufficient under all possibilities to keep the signal arm down—*i.e.*, "line clear." Where only one signal is worked, a single switch is used; where two or more signals are worked from the same box, multiple or commutator switches are used, making it impossible to "free" more than the right signals at one time.

All the signals and points which are not actually required to be in operation are locked, and cannot be worked at the same time as any others.

Messrs. Currie and Timmis employ secondary batteries, which for several reasons they consider better than primary batteries. There is a continuous current of electricity running while the signal arms are down, "line clear," so that the normal condition of every signal is at "danger." Every signal arm is pulled down "line clear" by its magnet; and, though at the moment of maximum 5 ampères is sufficient, a maximum current is provided of 10 ampères. When the armature of the magnet is home, *i.e.*, the signal arm is down "line clear," and the resistance is switched in automatically, the current is reduced to the "retaining" pull, which is taken at ·2 ampères. The time that each signal arm may be down "line clear" is calculated at twelve hours out of each twenty-four. The times that each signal arm may be lowered in each twenty-four hours is calculated at 150. On these data we have the following as estimated cost of current :—

150 lowerings of 2 seconds each = 300 seconds × 10 ampères = 50 ampère min. ... ... = ·8 amp. hour.
Retaining pull, 12 hours × ·2 ampères = 2·4 „ „

Amp. hr., per signal, per 24 hours = 3·2 „ „

C. as above = 3·2.
R. resistance = 5 ohms.
E. = C.R. = 10 (max. current) × 5 = 50.

$$\text{H.P.} = \frac{\text{C.E.}}{746} = \frac{3{\cdot}2 \times 50}{746} = {\cdot}2$$

This electrical expenditure per signal arm per 24 hours = ·2 H.P. = 1·2d. This cost is based on the assumption that E = 50, whereas the current used is only one-third of the maximum provided, which is double the maximum used, and the inventors thus estimate that the real cost of signal arm per twenty-four hours is not much more than ¼d.

MAGNETIC POLARITY AND NEUTRALITY.

By Professor D. E. HUGHES, F.R.S.*

As the results of a series of previous experiments, Professor Hughes formulated the theory of magnetism, viz. :—"That neutrality was a symmetrical arrangement, or a balancing of polar forces, as in a closed circuit of mutual attractions." The present series of researches bear unmistakable testimony to the truth of these views, showing the waves of opposite polarities which occur in iron, and that a symmetrical balancing of polar forces produces neutrality after each cessation of external polarity.

The instrument used for measurements consists of a delicate silk fibre-suspended magnetic needle, always brought to its zero-mark by the influence of a large magnet at a distance, the angle of which gives the degree of force required to balance any magnetised body placed on the opposite side of the needle. It can also employ electro-magnetic effects by the use of two opposing coils on each side of the needle, balanced so that an electric current passing through the coils has no influence on the needle, except when a piece of iron or steel is placed inside one of the coils; this again being balanced and measured by the large revolving magnet.

Before commencing the researches upon neutrality, the author felt that it was necessary to observe the curves of magnetic penetration, whilst under the influence of its inducing cause.

The methods employed consisted, first, in superposing twenty flat iron strips, ¼ millim. thick, 20 centims. long, and 3 centims. in width. These could be built up into a solid rod 1 centim. total thickness. Each piece was carefully selected and measured for its magnetic capacity, so that they should all be equal in value whilst under the influence of an inducing force, as well as their remaining magnetism when the influence ceased; the remaining magnetism being about ¼ of its capacity in the size and kind of iron employed.

These strips forming a compound bar were placed in contact with the poles of a strong permanent magnet, or they could be laid on one pole, the object being to polarise the lower bar only by contact, and observe the degree of penetration. The upper strip was carefully separated, whilst the remainder was left under the polarising influence. Each bar could thus be separated while under the influence, without fear of reactions taking place between the separated bar and its companions. There was thus a bar or strip, separated while under the inducing influence, and, knowing its coefficient of remaining magnetism, its full power could be estimated when under the polarising influence. By this means the values were plotted graphically, giving curves of varying degrees, as the inducing force was changed, or the material of the strip iron from soft iron to hard steel. These curves were verified by a somewhat similar method, using a separate strip whose coefficient of remaining magnetism was known, and drawing this over the poles of a magnet, but separated from it by different degrees of thickness of iron.

These again were verified by an electro-magnetic method, in which a series of concentric tubes divided lengthwise was

* Abstract of paper read before the Royal Society.

employed, so as to allow separation without friction, confirming the numerous curves obtained by the previous methods, showing that with a limited magnetising power acting upon homogeneous iron or steel, the penetration is inversely as the square of the distance from the inducing power, but with high powers the exterior soon arrives at its saturation, the distant layers rise in value, and also if the bar is not homogeneous there is a consequent deformation, owing to the comparative rigidity of its molecules.

In all cases, whatever the force employed, or nature of the iron or steel, there are no reversals of polarity in the interior, but a constant diminishing curve of penetration, from the outside to the centre. This changes, however, the instant the exterior polarising force ceases, the different degrees of force between the external and internal react upon each other, producing the following results:—

Internal Waves of Opposite Polarity.

All varieties of iron and steel have a high magnetic capacity whilst under the influence of its inducing force, such as the electro-magnetic coils, or strong permanent magnets, but this power in a great measure disappears on the cessation of the inducing influence, a return more or less perfect towards neutrality being the result; remaining magnetism is therefore a partial neutrality, more perfect in soft iron, where the molecules are in a greater state of freedom, than in comparatively rigid cast steel. So-called permanent magnets are therefore simply the remains of a far higher magnetic state, and it is already in most cases halfway down on its road to neutrality.

It is absolutely necessary in a theory of magnetism that we should know the cause of neutrality, for it is really the starting-point to appreciate how polarity becomes evident.

The first method of experimenting consists in forming compound bars of ordinary hoop-iron, ¼ millim. thick, and 30 or more centims. long, twenty or more of which could be superposed, bound together by a fine copper wire and forming a rod of any desired thickness; they were magnetised by drawing over magnets of various powers, and the degree of approach to neutrality observed by the amount of its remaining magnetism. Now, on carefully separating them, there were invariably found violent curves of opposing magnetism, previously held bound by the closed circuit of mutual attractions.

The second method consists in superposing the divided concentric tubes, already mentioned, bound together by a fine copper wire, and magnetising them in the electro-magnetic coils of the measuring balance; by this means we could observe the charge or full magnetic capacity under the influence of an electric current, the remaining magnetism upon its cessation, and after taking out the tubular core, separate it, and observe the polarity of its successive internal layers. This method is objectionable, as the slightest rubbing of one tubular surface against another may alter the true value. The electro-magnetic method is however infinitely superior when observations are made on solid bars, or tubes of different degrees of thickness, to observe the influence of depth or thickness, in producing a perfect return to neutrality after cessation of the inducing effect of the coils.

The third method was a chemical one, somewhat similar to that employed by Jamin, except that as the object was to study the curves of neutrality, the bars were of annealed steel, highly magnetised in the coils, and afterwards reduced almost to a zero, by vibrating them, or beating them gently with a wooden mallet. By dissolving the exterior in various dilute acids, and by taking repeated observations, it was possible to draw graphically the waves of opposing polarities, which have produced external neutrality.

The curves obtained by the different methods are identical in form. The simplest and most accurate method is the first.

If we take a compound bar of the hoop-iron, and draw the lower side over the south pole of a magnet, it will be found nearly neutral, or if not sufficiently so, we can reduce it by slight blows with a mallet; suppose the united bar gives still a remaining magnetism of 18° on the magnetic balance, on separating the components and observing the same ends, we find the lowest (or the bar which had touched the magnet) 150° north polarity, the next may be slightly north or zero; the rest will have varying degrees of south polarity, from 60° to 10°, the total of which exactly balances the north polarity of 150, less 18°, which we already observed as the remaining magnetism.

If we do not wish to approach a perfect neutrality, we should not vibrate the rods. In this case we may have 75° of remaining magnetism, and find on separating the strips, that we have on lower strip 150° north, and the total opposing south polarity of the interior but 75° south, leaving the remaining 75° of north polarity first observed on the compound bar unbalanced.

The mutual reactions between the magnetic molecules in a solid bar are precisely similar to those between two or more separate bars, the reactions in the solid bar being more pronounced and complete than those obtained through a separation of air; the greater the separation the less the reaction, but in no case will the law of neutrality be changed.

In homogeneous iron or steel, we have a well-defined curve, the distance of which can be calculated from observation upon the remaining magnetism, but if the interior is harder than the exterior, the inner portion will from its rigidity preserve its previous magnetism, reversing entirely the outer portions. This occurs also in small electro-magnets.

The author has been enabled to prove this by the chemical method, employing either dilute sulphuric acid, acidulated bichromate of potass, or dilute nitric acid (1 part acid to 5 water), the latter being far more rapid and equal in its action. The following experiment will show rapidly the influence of the outside reversal polarity. Take a soft steel wire 1 millim. diameter, 10 centims. long, magnetise it in a coil, or by drawing over a strong permanent magnet, so that it has perhaps a remaining magnetism of 200°. If we vibrate this rod or give several blows from a mallet, we can reduce this to 25°; we have now almost perfect neutrality, having only a remaining magnetism of 25°, which remains a constant for years if not remagnetised. Place this rod in dilute nitric acid, and in fifteen minutes it will rise to 50°, or double its previous value, in one hour to 75°, and two or three hours to 100°, or four times its previous force; the increased force of 75° has been rendered evident by dissolving an equal opposing polarity of 75°, so that we have already found 75 + 75 + 25 = 175°, or 87 per cent. of its highest force. This is so easily repeated with soft steels of all sizes and dimensions, that there can no longer be any doubt as to the existence of the outside reversed polarity. The experiment is more difficult to repeat with soft iron, as from the freedom of its molecules a fresh outside reversed curve is formed anew as the exterior is dissolved, the balancing curves reproducing themseives until we have almost entirely dissolved the iron; still with care, and iron not too soft, we can render evident all the neutral curves seen in steel.*

A perfect curve of opposing polarities can be obtained by placing a glass vessel containing the steel and solvent in the balance itself, taking continual observations during its solution, and we may thus observe the gradual rise in force to a maximum, then its fall to zero, to an opposing polarity, completely verifying all previous observations.

Supposing the magnetised steel previous to heating gave 200°, we should reduce it to 50° if heated to dull red, a bright red heat would probably reduce it to 20°; we should then start from an almost perfect neutrality to find, on dissolving its exterior (and allowing for the reversed polarity of the reversed portion), all its previous polarity.

Faraday remarked that the magnetic qualities of iron disappeared at yellow-red heat (1050° C.), reappearing gradually when cooled to red heat (700° C.). The author has found that if we heat the steel to yellow-red heat the whole previous structure disappears, and does not reappear on cooling.

If we place in the coil of the magnetic balance bars of iron or steel of different degrees of thickness, and observe their magnetic capacity whilst under the influence of an electric current, and the degree of remaining magnetism on its cessation, the extraordinary influence which thickness has in allowing space for the opposing waves of polarity to produce instantly a higher degree of neutrality than is possible without its aid, may be observed.

The conditions of the experiments are really those of ordinary electro-magnets, the iron or steel under observation is simply at the time of observation a core of an electro-magnet.

If we place in the coil of the balance different thickness of the same diameter and length of iron or steel, we notice a marked rise in its exterior force or magnetic capacity while under the influence of the electric current, and upon its cessation an equally marked return to a more perfect neutrality with each increase of thickness. The following table contains sufficient examples to show this clearly:—

TABLE I.

			Magnetic capacity under influence of the coil. 1 Daniell element.	Remaining magnetism on cessation of the electric current.
1.	Tube of thin, soft iron, 2 cent. diam., 20 cents. long, $\frac{1}{10}$ millim. thickness		218°	106°
2.	Similar size solid rod of soft iron		960	29
3.	„ „ cast steel, tempered		458	18
4.	„ „ bundle of 1. millim. diameter soft iron wires		1268	142
5.	„ „ glass tube filled with iron filings		160	15
6.	Soft Swedish iron wire, 1 millim. diam. ...		455	105
7.	Hard tempered cast-steel wire, 1 millim. diam.		49	16
8.	Brass tube	Electro-plated with iron extremely thin	3 cents. diam. 20 „ long	0·95	0·94
9.	„	Electro-plated with iron to $\frac{1}{10}$ millim. thickness	„ „	231	109
10.	„	Ditto, 1 mill. thickness	„ „	401	72
11.	„	„ 1 centim. „	4 cents. diam.	1075	35

Comparing No. 1 of the table (consisting of an extremely thin sheet iron tube) with No. 2 (a solid bar of iron of exactly similar

* Thin flat steel, such as clock-springs, saw-blades, or ribbon steel, well annealed, are most suitable for this experiment. They may be of any width or length; the thickness may vary between ½ and ¾ millim. The author has found that stripe of ¼ millim thick give the highest result.

size), we have for the thin tube a remaining magnetism of 50 per cent. of its previous polar force, and in the solid bar we have only 3 per cent.; whilst in the solid bar, where the opposing waves of polarity could easily form and produce a near approach to neutrality, we find that its polar force under the influence of the coil, is 400 per cent. greater than that of the thin tube.

Although, as well known, hard steel has a higher retaining power, still this can be reduced far below that of the soft thin iron if sufficient thickness is allowed, in order to produce the internal reactions. This is shown in No. 3, where a solid 2 centims. diameter of hard-cast steel has double the force of the thin soft iron under polarising influence, and its remaining magnetism only 4 per cent. of its previous force. This shows clearly that Jamin's views of the superiority of thin steel bars over thick where permanent magnetism is desired, are fully confirmed, as in order to have raised the cast steel 2 centims. thick bar to a high remaining magnetism, we should have had to employ at least fifty times stronger inducing force than that necessary for the thin bars. The proportion of remaining magnetism in iron or steel to the inducing force is almost similar throughout the entire range up to saturation, where the remaining magnetism is no longer proportional to the inducing power, but remains a constant, no matter how high and powerful the influence excited. The molecules have simply then rotated to parallelism, and cannot rotate further without diminishing its force, and the sudden spring back to a partial neutrality is then the same for all forces above that of saturation. The proportion of remaining magnetism to that of its magnetic capacity under the influence of an inducing field, is shown in Nos. 6 and 7, where iron and steel wires of similar diameter have not a wide difference, the remaining magnetism here being 25 per cent. for iron, and 33 per cent. for steel of its proportionate previous force.

The most conclusive experiments, however, will be seen in Nos. 8, 9, 10, and 11. No. 8 being a brass tube coated with an exceedingly thin transparent coat of iron, this thin coating of iron was easily raised to its saturation by a feeble battery, from which point no increase of battery power had the slightest effect, giving always 0° ·95. The extraordinary effect of thinness was seen on taking off the inducing influence, no perceptible movement of the needle on the balance occurred, indicating that its retaining power was the same as its capacity, or 100 per cent. of retention; vibrations and hammering which reduce a solid bar at once to perfect neutrality had no effect. The author has, however, marked it down as 0° ·94 as a limit of experimental error; if we assume only 80 per cent. of its previous force, it is still sufficiently remarkable. At No. 9, where the brass was coated to a measureable thickness of $\frac{1}{10}$ millim., we already see a better return to neutrality, having now only 50 per cent. of proportionate remaining magnetism; at No. 10, where we have 1 millim. thickness, we have improved our neutrality by having only 20 per cent., and at No. 11 we have, by means of an increased thickness of 1 centim., almost completely allowed the balancing waves of opposite polarity perfect formation, the remaining magnetism now being only 3 per cent. of its proportional power; and if we even neglect the proportional power, we see that the 1 centim. bar has far less remaining magnetism than that of 1 or $\frac{1}{10}$ millim., while its magnetic capacity is far higher.

No. 4 shows than while bundles of wires have a higher remaining magnetism than solid (due to the want of homogeneity allowing perfect formation of the opposing waves), still from their increased surface exposed to the inducing effect, they give a higher magnetic effect, the differential effect (as that employed in temporary electro-magnetic and induction coils) is greater, being here for solid bar $960-29=931$, and for the bundles of iron wire $1,268-142=1,126$ useful effect.

If we require a continuous magnetic effect, as in the field magnets of dynamo machines or small constant electro-magnets for extremely feeble electromotive force, solid cores or bundles of wire of large diameter should be employed, but as the time of charge and discharge increases with the diameter, it would be unsuitable for electro-magnets requiring rapid charges, such as those employed for telegraph relays, large electro-magnets requiring several seconds to charge them to saturation, while extremely small electro-magnets may be saturated in the $\frac{1}{1000}$ part of a second.

The effect of thickness even upon finely-divided iron such as filings, is shown in No. 5, where the remaining magnetism is only 9 per cent. against 50 per cent. as shown in No. 1, and we have precisely similar results with thin slices of iron filings as we do with the solid iron in sheets or tubes.

The experiments cited in the paper are of an extremely simple nature, and after being verified by independent observers, we can no longer doubt as to the cause of neutrality.

Whatever theory we adopt as an explanation of evident magnetism, it will be found that neutrality occurring after the cessation of an external inducing force upon a bar of iron or steel, is the result of symmetrically opposed polar forces, producing apparent waves of opposite polarity, or reactions between the exterior and interior of a bar of iron.

The Submarine Cables Convention.—A telegram from the *Times* correspondent at Paris, dated March 14th, states that the International Convention for the protection of submarine cables was signed on that day at the Foreign Office by all the European and various other Powers to the number of 28.

NOTES.

Electric Lighting.—The installation of electric light at the Holborn Restaurant, which was fitted up by the Edison Company, has been running successfully now for over a year. The dynamos are driven by two of Ransomes, Head & Jefferies' 16 horse-power engines, fitted with their automatic governor. The engineers in charge of the installation report, says the *Contract Journal*, that though the engines have often been worked very considerably above their guaranteed power, they have not shown signs of undue wear, and have worked very satisfactorily. They also report that the governor controls the speed very well indeed.

Last Saturday evening a small gathering of visitors were afforded an opportunity, by Mr. Robert Hammond, of Hilldrop, North Grove, Highgate, of inspecting his house as illuminated by the electric light. He has a 7-horse power gas engine on the premises to generate the electricity, and this represents a force in excess of what is required. The expense must in any case be considerable, but in return for it Mr. Hammond has a light which, in purity and brilliancy, is so superior to gas, that he probably regards this drawback as of secondary consequence.

From what we can gather it appears that the proposed experiments in electric lighting to be carried out at Wimbledon by Mr. W. H. Preece, F.R.S., will be of a more valuable and practical nature than anything which has hitherto been undertaken. The most favourable conditions for working both arc and incandescence lamps will be ascertained, and it is likely that we shall get very precise information as to the actual cost of lighting by electricity.

We had occasion to pay a visit to South Kensington Museum on Tuesday evening last, and were somewhat disappointed with the electric lighting. Why do not the authorities see that the lamps are properly adjusted so as to avoid such flickering as was painfully evident on the night in question? We noticed, in addition, that the lamps of the Electric Sun Lamp Company, and also the incandescence lamps in the reading room were not in operation. How is this?

Considerable dissatisfaction, says the *Postal Gazette*, has of late arisen among the inhabitants of Chesterfield in regard to the manner in which the streets of the town are illuminated. The dissatisfaction has culminated in a requisition, signed by the principal residents, to the mayor, to call a meeting of ratepayers to discuss the question. His Worship deferred a decision for six days, intimating that in the meantime circumstances might arise which would obviate the necessity for calling the meeting. At present the streets of Chesterfield are lighted by electricity, but in some quarters there is a strong feeling in favour of a return to gas.

The Telephone.—Among the arguments used by the advocates of the Bell Telephone monopoly, in their efforts to keep up heart against the convincing evidence adduced in support of Drawbaugh's claims as the original inventor of the telephone, is the silly reiteration that the latter delayed too long in applying for a patent, and that because of this delay, his invention was abandoned and his claims are outlawed. In "Simond's Summary of Patent Law" it is clearly stated, in treating on the question of the abandonment of an invention: "The conclusion is that abandonment may occur at any stage, before application, during application, or after grant of patent—that abandonment may take place in a short time, under circumstances clearly showing an intention to abandon, and may not occur through the delay of many years' duration, when sickness, poverty, or other matters of gravity really constrain the delay; and that, in any case, it must be proved—never being presumed—beyond all reasonable doubt." The same authority cites the case of Colgate *v.* Western Union Telegraph Company, 14 O. G., 043, in which the judge excused a delay of *ten years* in presenting an applica-

tion for patent on the ground of poverty. In the face of the evidence, which clearly establishes Drawbaugh's priority as the inventor of the telephone, and of the law, which as clearly shows that he is entitled to governmental protection, in the shape of a patent, for that invention, much can be pardoned in the Bell advocates who see their golden harvests of monopoly surely vanishing, but even this desperation cannot excuse them from becoming willing disciples of Annanias.—*New York Economist.*

The Telephone Companies' Bill.—The Holborn District Board of Works, consequent upon a communication from the Board of Works for the Wandsworth district, has resolved to petition Parliament against certain clauses of the Telephone Companies' Bill, more especially that permitting the compulsory entrance upon premises in order to lay telegraph or telephone wires.

Telegraphic Communication between England and Scotland.—In the House of Commons on Monday, in reply to Mr. Buchanan, Mr. Fawcett said interruptions of telegraphic communication between England and Scotland have been very frequently under consideration. They have not occurred in any particular locality, but have been experienced in various parts of the country traversed by the several main lines of telegraph between London and Scotland. The placing of any one section of the lines underground would not, therefore, insure immunity from interruption, while the cost of substituting underground wires for overground throughout the United Kingdom, or even between the principal towns, would be very great, probably not less than a million and three quarters.

Secrecy of Telegraph Messages.—In the House of Commons, on Thursday, the 13th inst., Mr. Fawcett, in answer to Mr. H. Fowler, said any persons in the employment of the Post Office giving information as to the persons sending telegrams, the persons to whom they are sent, or the contents of such telegrams, would not only be dismissed from the public service, but would, by section 20 of the Telegraph Act of 1868, render themselves liable to prosecution. In November last two telegraphists were convicted at Manchester of disclosing the contents of telegrams, and were sentenced—one to 12 and the other to six months' imprisonment; while a man, not in the service of the Department, who solicited the information, was also sentenced to 12 months' imprisonment.

Telegraphy in Western Australia.—Considerable inconvenience, says *The Colonies and India*, has been occasioned owing to the continued interruptions in the telegraph between Albany and Adelaide, and it was believed that if Sir Julius Vogel's cable scheme for the colony was carried, a duplicate wire would be essential on the overland line.

Cable News.—The ss. *Scotia* left on Monday, the 10th inst., with some 1,200 miles of cable. She will first lay the duplicate Madeira-St. Vincent section, and then repair the St. Vincent-Pernambuco portion.

Cable Communication with Holland.—The *Daily News* announces that one cable between the Dutch and British coasts has been restored.

Post Office Telegraphs.—The latest accounts published of the Postal Telegraph Service, which bring the figures down to the end of 1883, show that in the last year the total receipts amounted to £1,768,070, and the total expenditure to £1,583,876, leaving a balance of £184,193. When the telegraphs were transferred to the State in 1870, the figures were—expenditure £350,376, and receipts £612,301.

The Foucault Experiment.—Mr. Wilmer Smith, of Goderich, Ontario, in a letter to the *Scientific American*, dated February 18th, 1884, says:—"In your issue of January 12th, one of your correspondents, referring to the Foucault experiment with the pendulum, which is said to prove the axial motion of the earth, expressed a great desire to have the experiment repeated in Washington. I sincerely hope a committee of scientific men will take the matter up, and test the experiment thoroughly, and demonstrate beyond dispute the truth or falsity of it. Because, aside from the pendulum experiment, we have no *direct, palpable* proof of the axial motion of the earth. Quite recently a number of scientific gentlemen in Great Britain and some of the public journals asserted the Foucault experiment false, coming to that conclusion after repeated tests of their own. In many cases the experiments have shown *no change* at all in the plane of oscillation of the pendulum; in others the alteration in the plane of vibration has been in the *wrong direction*, and very often the *rate* of *variation* has been altogether different to that which theory indicated. The *Liverpool Journal* states that a scientific gentleman in Dundee tried the pendulum experiment, and said that, as far as proving the axial motion of the earth was concerned, it was a gross delusion; but that it tends to the *magnetic meridian* he found to be a fact. The *Manchester Examiner* also reports an experiment by the Rev. H. H. Jones, F.R.A.S., in the Library Hall of the Manchester Athenæum, in which the rate of variation was *entirely different* to the accepted theory. Did space permit, I could give particulars of several other experiments with like results. Now, in the face of all this, I agree with your correspondent, that a thorough test of the Foucault experiment ought to be made in Washington to prove the truth or falsity of it. I would also suggest that two pendulums be used, one of metal the same as Foucault's, another of wooden rods pinned and glued together and glass ball, or constructed of some perfect non-conductors of electric and magnetic currents. A cord would not answer, as the torsion might cause the pendulum to vibrate with a circular motion; the point of suspension ought also to be non-conducting, resting on a glass bearing. My idea for having one pendulum a perfect non-conductor is, that if a metal one is affected by electric currents or the magnetic meridian, the other would not be. Then if the two pendulums continued their oscillations in exactly the same plane, I think it would prove that electric or magnetic currents had no influence on the direction of their vibrations. In starting the pendulum great care is required to avoid giving any bias from the true plane of vibration. In the experiments referred to, a thread having a loop at one end was passed over the pointer on the under side of the ball, the pendulum drawn back and tied. When perfectly at rest the thread was burned apart, and the pendulum started on its course, the loop falling off. I would like to see immediate steps taken for a thorough practical test of this celebrated experiment."

Permanent Magnet Siphon-Recorders.—The *Monthly Correspondent*, of Madeira, has an article this month on the recorder proposed some two or three years ago by Mr. Chevallier. This gentleman was desirous of substituting permanent magnets for the electro-magnets, with their accompanying cumbersome and costly batteries which have hitherto been employed for producing the intense magnetic field necessary for working the siphon-recorder on long cables. It appears that the new instrument, which is being tried at Carcavellos, differs but in three respects from the recorder supplied more than a year ago to the Madeira station. 1. The former has a permanent magnet, the latter an electro-magnet. 2. The Carcavellos instrument has a device which does away with the back fibre adjustment of the signalling coil. 3. The Carcavellos recorder is not furnished with shunts, whilst that at Madeira has "sending" and "receiving" shunts, arranged in a novel and convenient manner. Our contemporary concludes that the general working of the new style of recorder is much about the same as that of the old instruments, with the exception that the increased

strength of the magnet adds greatly to the sensitiveness of the apparatus. The absence of any device for adjusting the strength of the magnetic field is pointed out as a drawback which might have easily been remedied; as it is, the signalling coil, before it will give readable signals, has to be heavily shunted.

Re Devon and Cornwall Electric Light and Power Company, Limited.—This was an appeal before Lord Justices Cotton, Bowen, and Fry, on Wednesday, by the Hon. F. W. Cadogan, a shareholder in the company, against an order for winding up the company made by Mr. Justice Chitty on the 24th of April, 1883, on the petition of another shareholder. Mr. Cadogan had shortly after the presentation of the petition taken proceedings and obtained an order for the removal of his name from the company's register on the ground of misrepresentation in the prospectus, but the order was stayed pending the proceedings on the petition. He opposed the making of a winding-up order on the ground that he would be liable as a contributory, not having commenced proceedings and put an end to his liability as a shareholder before the petition for winding up. He contended that it would be inequitable to make the order under the circumstances. Lord Justice Cotton, in delivering judgment, said that 37 out of 149 shareholders said they had been defrauded into taking shares, and that in consequence of the reduction in the capital of the company, and for other reasons, there was no reasonable prospect of the company going on, but it was dead as a commercial undertaking. In the opinion of his lordship, if even a small minority of the shareholders were desirous of going on, it would not be right for the court to make a winding-up order, because the requisite majority might pass a resolution for voluntary liquidation. But in this case a meeting of the company had agreed that the company could not go on, and there was not a single shareholder who wanted the company to go on with himself as a partner in the concern. The only persons who wanted it to go on were those who, like the appellant, wished the winding up to be stayed until they could sever their connection with the company. There was nothing unreasonable in making a winding-up order, because the order would prevent the proceeding taken by the appellant, after the presentation of the petition, from having any effect. The appellant had commenced his proceedings too late, and could not say the winding-up proceedings were inequitable. Lord Justices Bowen and Fry concurred, and the appeal was dismissed with costs.

The Society of Telegraph Engineers and Electricians.—The next meeting of the society will take place on the 27th inst., at the Institution of Civil Engineers, 25, Great George Street, when the following papers will be read:—"On the proportion which ought to subsist between the Size of Conductors and the Strength of Currents." By Professor George Forbes, F.R.S.E., Member. "On the relation which should subsist between a Current of Electricity and the Conductor employed to convey it." By Thos. H. Blakesley, M.A.

French Electrical Power Storage Company, Limited.—A petition for the winding up of this company, presented by Messrs. Woodhouse & Rawson, of 11, Queen Victoria Street, is directed to be heard before Vice-Chancellor Bacon, on Saturday, the 29th inst.

British Association's Canadian Meeting.—The *Postal, Telegraphic, and Telephonic Gazette* states that the telegraph companies will transmit messages from scientists attending the Canadian meeting of the British Association to all parts of the Dominion and the States free of charge.

British Association.—Sir Lyon Playfair, K.C.B., the *Times* announces, has been nominated to, and has accepted, the presidency of the British Association for the meeting to be held in Aberdeen next year.

Personal.—We learn that Mr. F. W. Ford, who has for more than five years acted as assistant to the Secretary to the Society of Telegraph Engineers and Electricians, is now on the staff of the Institution of Mechanical Engineers.

On the Observation of Earth Currents.—By M. Larroque.—The author sums up his observations by saying that the intensity of the earth-current undergoes secondary fluctuation depending on the degree of moisture and on the temperature of the zone of soil included in the circuit; that the electromotive forces are developed at the contacts; that long lines are exposed to secondary actions, which may be due to their introduction into regions of an opposite electric sign; to the electrostatic induction which the earth may exert upon the wire; to atmospheric changes when the line is suspended and exposed; and to magnetic induction when the wire is magnetic. The method adopted by M. Blavier for eliminating these various secondary actions, and the results which he has obtained, are not to the point. But there exists another method, more practical in the author's opinion, which consists in making observations upon very short lines, which can be conveniently fitted up in the premises of an observatory. A net of four or five lines of some metres in length, radiating around a point, and sheltered in a shed or a cellar is sufficient for all purposes. Under these conditions the secondary actions are eliminated to a great extent, and there is the advantage of making use of a wire of little resistance and non-magnetic. This last condition is important for examining if the earth-currents are the cause or the effect of terrestrial magnetism.—*Comptes Rendus.*

NEW COMPANY REGISTERED.

Railway Electrical Contractors, Limited.—Capital, £25,000, in £5 shares. Objects:—To enter into an agreement with Mr. Thomas Marshall Collet, and to acquire inventions for lighting railways, trains, and carriages by electricity or otherwise. Signatories, *Sir Daniel Cooper, Bart., 6, De Vere Gardens, 50 shares; John S. Sellon, 78, Hatton Garden, 50 shares; Capt. F. Pavy, Beckley, 50 shares; W. J. Cordner (electrical engineer), 50 shares; *John Pender, M.P., 18, Arlington Street, 50 shares; Harold Collett (electrical engineer), 25 shares; *T. Marshall Collet, 4, Great Winchester Street, 50 shares. Directing qualification, 50 shares. Remuneration, £300 per annum, or such greater sum as may equal 10 per cent. of the net profits, but not exceeding £1,500 per annum. The signatories denoted by an asterisk are the first directors. Registered 12th inst., by Messrs. Trinders & Co., 14, St. Helen's Place.

OFFICIAL RETURNS OF ELECTRIC COMPANIES.

British Spiral Telephone Wire Syndicate, Limited.—Two agreements were filed, with the documents of this company, on the 15th. The first is dated 3rd of December, 1883, and is between Mr. Gorham Gray, of Boston, Mass., and Mr. Wm. Downie, the managing director of the Anglo-American Patent Development Company, Limited. This agreement relates to the formation of a syndicate for the purchase of the British and other European and Colonial patent rights (Canada excepted), granted to Mr. Gray in respect of an invention for spiral wire for telephone and telegraph purposes, with the machines for making the same. The purchase consideration is to be £35,000, payable £10,000 in cash, and £25,000 in fully paid shares, of which amount Mr. Downie, on behalf of the Anglo-American Patent Development Company, is to receive £11,750, partly in cash and partly in shares. The second agreement is dated 14th January, and is

for the purchase by the syndicate of the said patent rights at the price named in the second agreement.

Liverpool Electric Supply, Limited.—The second return of this company, made up to the 10th inst., was filed on the 15th inst. The nominal capital is £10,000 in £5 shares; 674 shares have been allotted, and a call of £4 per share has been made, the calls paid amounting to £2,456, leaving £240 unpaid. 250 shares have been taken up since the last return was made, and the paid up capital has been increased by £1,748.

DISSOLUTION OF PARTNERSHIP.

Timmins, Edward Philemon, and **Rose, Joseph,** 2, Bute Place, the Docks, Cardiff, consulting and electrical engineers.

CITY NOTES, REPORTS, MEETINGS, &c.

British Insulite Company, Limited.

An extraordinary general meeting of this company was held on Tuesday at the City Terminus Hotel.

The Right Hon. E. P. Bouverie presided, and stated that at the meeting about six weeks ago an examination of their accounts led to the impression, which seemed to be justified by the figures contained therein, that the business of the company could in no circumstances be a profitable one. He, therefore, promised that they would have a more thorough investigation by their skilled auditors, Messrs. Price, Waterhouse, & Co., and that as soon as the result was known, another meeting of the proprietors should be called. The investigation had been made, and was stated in the report, which had been printed, and the simple explanation of that which had startled them at their last meeting was this—that a very large addition had been made to the manufacturing charges which was not due to it, but which represented salaries and goods, and a considerable amount of wages spent in the early part of last year in connection with experiments. The total result was that they were better off with respect to manufacturing profit by £1,223 than they appeared to be by the accounts submitted at the last meeting. At the suggestion of Mr. Waterhouse an examination had also been made of the working for two months of the present year—to the 25th ult.—and on the operations of that period there had been a gross profit of between £700 and £800. The directors were as thoroughly satisfied as ever of the scientific value of the material with which they dealt. He had been in communication with the chairman of the parent company who sold the patents to this company, in order to induce the chairman of the parent company to consent to transfer their foreign patents to this company. The basis of the terms had been sketched out, and the main onerous condition would be that a moiety of any capital sum obtained by this company on the sale of those patents should be for the benefit of the original company. They proposed to make a call of £1 a share, payable on the 30th proximo. They owed a considerable sum to their bankers.

Sir George Rickards having seconded the motion, a discussion followed, in the course of which a shareholder expressed the opinion that the company was practically in a bankrupt condition, and he moved that it should be wound up.

The Chairman stated that no motion which was not on the paper could be put to the meeting.

Mr. Price (of the firm of Messrs. Price, Waterhouse, & Co.) afterwards stated the result of his recent examination of the accounts.

The Chairman, in reply to questions, said it was easy to say that there had been mismanagement, but the directors had done their best, and, on the whole, he thought they had not been unsuccessful. They did not contemplate making another call beyond the £1 mentioned, and the directors—who held very nearly one-fourth of the whole of the shares—did not wish to call up more than they considered necessary.

Ultimately the motion was carried by 18 to 9, and the meeting terminated.

The Gülcher Electric Light and Power Company, Limited.

On Tuesday afternoon, an extraordinary general meeting of this company was held at the City Terminus Hotel, Mr. Daniel de Castro presiding, for the purpose of confirming resolutions passed on the 27th ult., and for other business.

Mr. Russell Day, the secretary, having read the notice convening the meeting,

The Chairman moved the confirmation of the following resolution:—"That the regulations of the company be altered by the addition of the following regulations:—(*a*) The directors may accept surrenders of shares on such terms as they think fit, provided that no part of the assets of the company representing paid-up capital be employed in the purchase of the company's own shares. (*b*) The directors may sell any surrendered shares and register the purchaser as the holder thereof, and may cancel any share acquired by surrender, and may (unless the company otherwise resolve) issue new shares in lieu thereof."

Professor Crookes seconded the motion, which was carried unanimously.

The Chairman then moved the following resolution, which, he said, was really to give effect to the work of the last six months:—"That the conditions contained in the memorandum of association of the company be modified by reducing the capital of the company from £300,000 in 60,000 shares of £5 each, to £150,000 as in 30,000 shares of £5 each, and that such reduction be effected as follows:—By extinguishing 11,000 fully paid-up shares of £5 each, and 12,000 shares of £5 each having £3 10s. called up, and £1 10s. per share paid up or credited thereon, agreed to be surrendered by Messrs. Charles James Fox, David Johnson, and Newson Dunnell Garrett; by extinguishing 2,050 fully paid-up shares of £5, agreed to be surrendered by William Crookes, F.R.S., and 880 fully paid-up shares of £5 each, agreed to be surrendered by Robert Jacob Gülcher, and 880 fully paid-up shares of £5 each, agreed to be surrendered by Lorentz Albert Groth; and by cancelling 3,190 unissued shares of the company which have not been agreed to be taken by any person." This was substantially the result of the negociations with the promoters of the company, by which the latter gave up £70,000 as mentioned in the circular which the shareholders had received. £20,000 had also been surrendered by Messrs. Crookes, Gülcher, and Groth, vendors of the company. If carried, a subsequent meeting would have to be held to confirm this resolution.

Mr. Herbert Kelly seconded the motion, which was unanimously agreed to.

The Chairman said at the last meeting he mentioned that, instead of making a further call upon the shareholders, the directors proposed to raise the money they urgently required by issuing debentures. The board had agreed amongst themselves to subscribe £5,000 of the £12,000 they proposed to issue in that way, and they hoped the wealthier amongst the shareholders would subscribe the remainder. Those debentures would bear 6 per cent. interest, and would be secured on the whole property of the company. They had at present uncalled capital, assuming that the arrangements for reducing the capital was carried into effect, to the amount of about £25,000, upon which the debentures would be the first charge, and there was also stock, plant, and material worth another £12,000; arrears of calls and cash would produce from £8,000 to £10,000; and then there would be the investment of the money raised itself. They would be able to pay all their debts; and he thought, after they had received the £12,000, they would be able not only to declare a dividend, but make the shares of really marketable value. They were about to send in a contract, which they had a reasonable hope of obtaining, involving an expenditure of £6,000; and the Crystal Palace contract was involving, and would involve, a very considerable expenditure. They had installations at Margate, Liverpool and Huddersfield, from which they expected great results.

A Shareholder inquired if the opportunity would be afforded of making shares fully paid, and would in that case the same interest be paid?

The Chairman replied that the directors were quite willing to accept full payment on shares, in advance of call, but the interest then would be only 5 per cent., as there was the possibility of its lasting for ever, whereas the debentures were only a temporary arrangement.

Mr. Blundell moved a vote of thanks to the Chairman, which was accorded, and

The Chairman, in responding, remarked that all that was now being done was contingent upon the agreement with the promoters being carried out. That agreement was so eminently satisfactory to both parties, that he could not think there would be any doubt as to its being carried out. In addition to what he had already stated, the debentures would be a charge also upon the unpaid capital represented by the shares held by the promoters, and therefore the security was even greater.

The meeting was dispersing, when the Chairman announced that one of the directors had stated his intention of withdrawing his promised subscription of debentures as to £500, and proposed to pay up his shares in full instead.

This concluded the proceedings.

South Eastern (Brush) Electric Light and Power Company, Limited.

An extraordinary general meeting, called in compliance with a requisition signed by a number of shareholders, was held at the City Terminus Hotel, on Tuesday, under the presidency of Sir Michael Kennedy, K.C.S.I., for the purpose of considering the resolutions for reducing the capital of the company.

Mr. Alfred Jermyn, secretary, having read the notice convening the meeting,

The Chairman said: After the recent general meeting, which passed off so pleasantly, and at which I gave intimation that a call of 10s. per share would be made, we were rather surprised to be required to carry out an arrangement under which the capital of the company would be reduced to the amount already paid up. We thought we had satisfied the great majority of the shareholders that we had inaugurated a hopeful business, and that we

had confidence in being able to carry out our programme to that effect. I take it, therefore, that the measure which has now been pressed upon us has been called for in consequence of something that has subsequently occurred, and outside this company. I suppose there is a sort of general feeling that the prospects of electric lighting are not at the present moment good, and a desire to restrict the outlay of capital as much as possible and to wait for better times. Well, gentlemen, there may be, and perhaps is, something in this, but I would venture to remark that this company, in the opinion of the directors, is in a better position than most other companies which were started on similar lines for similar purposes, inasmuch as we have paid comparatively little for our concessions. Ours is the first company which has started an installation on a large scale, working from a central station, and under the provisions of the Electric Lighting Act; also, we are affiliated to, and have a large interest in, a manufacturing company which we believe to have a great prospect of success. At the ordinary general meeting we explained, as far as we were able, exactly what our position was, and at a conference which we have quite recently had with several of the principal shareholders —amongst others, the gentlemen who have signed the circular leading to this meeting—we went over the same ground again. We still think it will be better if no reduction be made in the capital, but if imperatively called for, we offered to consent to a reduction to £3 per share. We were, however, unable to convert the gentlemen who came to us to that view, and we consented to reduce to £2 10s. per share, those gentlemen agreeing to support us in that measure. Beyond that we cannot go, because our liabilities are in excess of any further reduction; besides which, the consent of the Court could not be obtained, and therefore it would be futile and abortive. Even this will involve the loss of our provisional orders, which cost us not only a great deal of time, trouble, and difficulty in obtaining, but also the sum of £2,000. Should our prospects turn out as we anticipate, and our business be extended, we shall have to go through all that expense and trouble again in order to get Parliamentary powers to work our district. We told the gentlemen who conferred with us, that if they would consent to reduce to £3 per share, we would agree not to call up more than £2 10s., unless we had the consent of the committee, before whom we would lay our reasons. But our proposal was not accepted, and we were therefore reduced to taking the utmost we could get, which was £2 10s. At the same time we indicated certain reductions in our general charges which we were about to make, and in order to show that we had full confidence in our judgment of the case we also agreed that we would not receive any further remuneration as directors until we had been able to earn and declare a dividend. (Hear, hear, and "Quite right.") What we want to see is the success of this company, and our chief desire is that the shareholders shall not lose the money they have already invested. We think this can be done in the way we have indicated. We made the proposal with regard to foregoing our remuneration in connection with the proposal to reduce the capital to £3, but we are not, of course, going to retreat from that position now that a further reduction is proposed; we will still carry out that arrangement, and we trust that we shall be able to show a good result. I will now, as a matter of form, call upon some gentleman to move the first resolution upon the paper.

Admiral Sir E. A. Inglefield asked what were the liabilities necessitating the call proposed, and whether they had arisen since the last general meeting.

The Chairman read various sums owing to other companies, &c., amounting to £9,245, and stated that they were not all incurred since the last meeting.

Admiral Inglefield stated that he was one of the investigation committee of the Metropolitan Brush Company, and as a result of the enquiries made by that committee the members were unanimously of opinion that, notwithstanding all the money spent in that company, and all the good work done, it was impossible to make the Holborn concession pay, or, indeed, any concession. If they agreed to this measure of limiting the capital to £2 10s. per share another call was certain, and he was satisfied that it was impossible, in the present state of things, to make electric lighting pay in any district; they might possibly pay 2 per cent,, but that would be a very small return upon the large capital invested.

Mr. Braithwaite inquired, respecting the item of £4,923 which the chairman had stated was owing to the Consolidated Electric Company, whether that amount was for batteries which had never been submitted to or tested by any competent electrical authority, and further, whether it was true that at Colchester it was probable £10,000 would be spent. His experience as chairman of the Great Western Company, was that if they were to put £10,000 into an installation in a provincial town, they would expect to lose from £2,000 to £3,000 a-year upon it.

Mr. Hewett having moved, and Mr. Braithwaite seconded, "that the capital of the company be reduced to the extent of the amount of the said capital uncalled,"

The Chairman said before putting the resolution he would explain that as regarded the Consolidated Company, their arrangement was to pay £10,000, if required, and one-half of that sum had been already paid. It was perfectly correct that the estimate for Colchester amounted to £10,000; and from the estimates they had framed, and the rates they were now receiving, they anticipated upon the installation of 2,200 lamps a return of 12½ per cent.

The motion was then put and negatived; the following, moved by the chairman and seconded by Mr. Fessor, being unanimously agreed to:—"That the capital of the company be reduced from £100,000, divided into 20,000 shares of £5 each, to £51,000, divided into 400 fully-paid shares of £5 each, and 19,600 shares of £2 10s. each, and that such reduction be effected by reducing the liability on each and every of the 19,600 shares to the extent of £2 10s."

The meeting then dispersed, a motion of thanks to the chairman and directors having been passed.

Direct Spanish Telegraph Company, Limited.

THE following report of the directors for the half-year ended 31st December, 1883, is to be presented at the general meeting of shareholders, to be held on Thursday, the 27th inst.

The annexed accounts for the half-year ended 31st December, 1883, show a balance to the credit of profit and loss of £4,645 2s. 6d.

The traffic receipts show a falling off of £870 17s. 7d. as compared with the corresponding half-year of 1882, during which no interruption of the Bilbao cable occurred, whereas during the last half-year, this cable has been interrupted from the 6th to the 27th August, and from the 24th November to the end of the year.

The Bilbao cable again broke down on the 10th February last, and steps have been taken for its restoration. The Marseilles-Barcelona cable has continued in excellent working order.

The directors have concluded a contract with the Telegraph Construction and Maintenance Company, for the construction and laying, before the 15th June next, of a duplicate cable between England and Bilbao, upon satisfactory terms.

As will be seen by the accounts, the directors have paid for the repairs of the Bilbao cable in August last, amounting to £2,052 11s. 1d., out of revenue, but have deducted the cost of the repairs of the second interruption in November, from the reserve fund, which is thereby reduced to £638 19s. 4d.

The dividend on the preference shares for the half-year will absorb £3,000, and after appropriating £200 to the reduction of preliminary expenses account, there will remain a balance of £1,445 2s. 6d., which it is proposed to carry to the reserve fund. The dividend warrants on the preference shares will be issued when the remittances from Spain for the balance of telegraph accounts to 31st December last are received.

With a view to more rapidly extinguish the preliminary expenses account, the directors propose to apply to the reduction of that account the £935 10s. 6d., amount of premium on the sale of the balance of preference shares, disposed of since 1st January, 1883.

Messrs. Bannatyne and Etlinger are the directors retiring by rotation, and being eligible offer themselves for re-election. Mr. Herbert R. Duke is eligible as auditor for the present year.

Stock Exchange.—Application has been made to the Stock Exchange Committee to appoint a settling day in and grant a quotation to the London Platino-Brazilian Telegraph Company, Limited, £100,000 6 per cent. debentures and other securities.

C. G. E. Terraneau.—Messrs. W. L. Grimwade and A. Edey, public accountants, have been appointed trustees of the property of this bankrupt. The public examination will take place on the 1st of April.

Maxim-Weston Electric Company, Limited.—This company's offices have been removed from 47, Cannon Street to 32, Queen Victoria Street.

The Continental Maxim-Weston Electric Company (N. de Kabath and H. S. Maxim) has removed to 57D, Hatton Garden.

Edison and Swan United Electric Light Company, Limited.—A call of 10s. per share is due on the 22nd inst.

The Lancashire Maxim-Weston Electric Company, Limited, has taken offices at 56, New Broad Street.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this Society was held on Thursday, March 13th, Professor W. G. ADAMS, President, in the chair.

The minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed new members, transfers, &c., announced, a paper, by Mr. W. H. MASSEY, member, on "A Train Lighting Experiment," was read by the Secretary.—But little is known of the actual cost of carriage lighting on railway trains, but it is hoped that the result of experiments which have been made by the author may induce others to take the matter up. About five months ago, Mr. Forbes had considered the subject with Mr. Massey, and at first the author thought that to apply electric lighting would be too expensive; in fact, that the cost would be greater than that of gas. The results of experiment, however, have proved that the reverse is the case, that is to say, as regards certain gas systems. There

is great difficulty in making a fair comparison, as the actual cost of lighting the carriages by gas has never been estimated properly. Twelve shillings per 1,000 c.f. has been estimated for enriched gas, but it is doubtful whether interest on capital, cost of repairs, &c., is included in this. To well light a first-class compartment, two 1-foot hour burners are required.

It was at first suggested that a small engine and dynamo should be fixed on the locomotive and driven direct from the boiler; but the Electric Light Company, who undertook the work, preferred that the whole of the generating apparatus, including the boiler, should be placed in a van, and the experiment was consequently made in this way. The actual trials were commenced at the beginning of the present year. The total weight of the gear, including two cwt. of coal, was under three tons. A Siemens 100-lamp machine was used, driven by a 7-H.P. Willans engine. Fifty-two lamps were actually employed, the engine working at 120 lbs. steam pressure. The conducting cables were carried in a wooden troughing along the roofs of the carriages, and were permanently joined, as the carriages were never uncoupled. There were three lamps in each first-class, one in each third-class carriage, and 20 lamps in the van; the head and tail lamps of the train were also electrically lighted. To avoid loose attachments caused by vibration, spring contacts were employed in addition to the ordinary ones. The only difficulty that occurred was from the slipping of the hooks. The train actually commenced to run with the electric light fittings on the 3rd of January, between High Street, Kensington, and Putney, and no hitch occurred except on one occasion, when a passenger removed a lamp bodily. The lamps were lit for 6½ hours each day, and after 15 days the boiler required cleaning. Generally speaking, the result of the experiment was most satisfactory. The important fact was established, that 211 lbs. of water evaporated at 120 lbs. pressure, would give 50 lamps of 16 to 18-candle power per hour. 4¼ H.P. would be consumed, 30 per cent. was wasted, and 15 per cent. lost in friction, making a total of 7¾-H.P. expended. 30 lbs. of water were evaporated per H.P. hour, and the consumption of coal was 2¾ cwt. each 6½ hours. The cost of producing the light was 3s. 9d. for coal, 3d. water, 1s. 3d. oil and waste, 3s. 6d. interest on plant and renewals of lamps; or a total of 11s. per 1,000 lamp-hours, the lamps averaging 18-candle power each. Out of 151 lamps only seven had failed. The first cost of the plant amounted to £170; if the engine and dynamo had been mounted on the locomotive, this cost would have been reduced to £120. £1 per lamp covered all other outlay, and £40 per annum might be allowed for interest on capital and for repairs. The total of 11s. per 1,000 lamp-hours, it should be pointed out, gave double the light of gas at 12s. per 1,000 c.ft. The cost might be taken as 30 per cent. less than that of gas lighting. With reference to the use of reading lamps by passengers, in consequence of the defective light in the carriages, he might mention that one firm supplied 60,000 candles a-year at 2d. each for these lamps. As regards the permanency of the electric lighting, there was no reason why it should fail more than air brakes should. The few experiments that had been made with primary batteries for lighting, he thought, were encouraging, but for regular work he thought the expense would be great. It had been suggested that the power for driving the dynamo might be derived from the axle of one of the wheels, but this seems an unnecessarily indirect way of getting the power; the author thought that Mr. Preece's method of accumulating power by compressed air would prove very wasteful, and would greatly increase the chances of a break-down occurring. He thought that to make the electric lighting of railway carriages a success, it must be effected on the lines he had indicated.

In the discussion which followed the reading of Mr. Massey's paper,

The PRESIDENT said that the extreme brilliancy of the electric light had been often complained of, but to burn the lamps at a low power very considerably decreased their economy, although no doubt they would last much longer. The proper thing to do was to arrive at a mean power which would give the greatest total economy. An 18-candle power lamp burnt at 10-candle power, had its efficiency reduced in the proportion of 144 to 100; that is with the Swan high resistance lamp.

Mr. W. H. PREECE said that the lighting of railway carriages was a disgrace to the present age. The difficulties which would exist in carrying out electric lighting had been foreseen; in most cases trains were not made up permanently as on the Metropolitan Railway, but in two or three sections which are afterwards separated; each section must, therefore, be considered as a separate unit and each must have a special van, &c., on Mr. Massey's system. If a train is left at a station for the purpose of being divided up, each section would for a time be left in darkness unless some special means were employed to prevent this. On the London, Brighton, and South Coast Railway secondary batteries had been tried with success, but only as regards the fact that the electric light could be produced and maintained. In this experiment the Electric Power and Storage Company took all the responsibility and so the number of failures were unknown. No secondary battery had yet been produced which was really a success, although many of the difficulties in the way were being overcome. He doubted whether the shaking up of the batteries was conducive to their efficiency. Primary batteries had been tried on the Midland and also on the Great Northern and South Western Railways. Speaking broadly, primary batteries might succeed, as the trouble in keeping them in order was not greater than that required in the case of an ordinary oil lamp. In the compressed air system, with which he was experimenting, the air pumps were worked off the axle of the carriage and the air was used to work an engine to drive a dynamo; the result was that a uniform motion was obtained. No difficulty was experienced in compressing and maintaining air at 500 lbs. pressure. The difficulty of the heating and cooling of the air was got over by placing the air chamber, pump, and engine in one tank, so that the heat simply became transferred. He thought the problem of train lighting by electricity to be practically solved. The item of cost he did not think was worth consideration so long as a good light was obtained. The cost of the fittings for electric lighting, as a matter of fact, was less than for gas, and the production of the light was also cheaper. Fittings for gas cost £65 per carriage, whereas a complete train of six carriages could be fitted for £170.

Mr. Gammon said that he had had some experience of Holmes and Burkes' primary battery system; 9 of these cells would give 6 5-candle lights for 6 hours. Trains had been fitted with these batteries for lighting the Pullman cars on the Great Northern and Midland Railways, and also on the South Eastern, Dover train. The London and South-Western "roundabout" train was also fitted with these batteries. The actual cost compared favourably with gas, and if the bye-products were sold, the economy would be still greater.

Mr. SHOOLBRED stated that on the London, Brighton, and South Coast Railway the first experiments were with secondary batteries charged from a dynamo worked off the axle of the carriage. Thirty 42 volt lamps of 20-candle power each were employed. A Siemens D_2 machine was used, and 22 secondary cells. In the second experiment a Brush machine and 20 cells were tried. The success was so great that the system was to be extended.

Mr. LANGDON said that on the Midland Railway the electric lighting of the carriages was effected by 2 lights in one compartment, and one in each of the others, their being 6 compartments in all; two lamps were also placed in the guard's van. Each of the lamps was of 5-candle power. The Holmes and Burke battery was used, the power consisting of 15 cells, connected in 3 sets of 5. The electromotive force per cell was 1·85 volts, and the internal resistance $\frac{1}{10}$th of an ohm. The battery could last for 10 hours each day, but then required cleaning. The plates had to be reamalgamated twice a week. The charging solution was 1 part of sulphuric acid to 12 of water for the zinc cell, and a liquid called oxydone for the carbon cell. Fumes were given off, but did not cause any inconvenience. The experiment may be regarded as being a successful one. He agreed with Mr. Preece with reference to the badness of the lighting of carriages. He thought it preferable to have two lights rather than one only in each compartment to provide against accidents. The best method would be for each carriage to have its own lighting arrangements, but this would hardly be feasible. The necessity for dividing up trains was a considerable difficulty to be overcome.

Mr. A. SIEMENS said that three years ago an experiment had been made on one of the Scottish railways with reference to lighting the carriages by electricity, but the want of funds prevented the experiment being extended. He thought that the best method of lighting was to have the engine and dynamo on the engine. He did not believe in primary batteries, as they cannot be cheap. Inventors of these batteries have invariably refused to allow the same to be tested, neither will they state what chemicals are employed for exciting them.

Mr. R. E. CROMPTON considered that the good results obtained by Mr. Massey were in a great measure due to the use of a Willan's engine; it was only high speed engines which would give economical results. The objection as to the breaking up of trains he did not think a great one, as few people would mind being in darkness for a few minutes. The primary battery question he found could never be discussed amicably, but he agreed with Mr. A. Siemens as to the impracticability of their use. Two 18-candle lamps could not be lighted with these batteries, and he did not think that less than 18-candle power was sufficient.

Mr. COLLETT, in reply to Mr. Preece, said that of the 70 cells supplied by the Electric Power and Storage Company, only 7 had failed; jolting did not affect the cells, as 18 months experience had proved. He did not agree with Mr. Crompton with reference to trains being left in darkness for a few minutes. He thought that many passengers would consider this most objectionable. To enable a train to be lighted sectionally, secondary batteries were indispensable.

Professor FORBES referred to the lighting of the head light of a train on the Munich Railway in 1882. This was effected by means of an engine and dynamo on the locomotive. The engine was the 4-cylinder Abraham's type, and the dynamo machine of the Schuckert pattern. In the only case where he had succeeded in obtaining a primary battery to test, the result proved that its efficiency was no greater than that of any other form of battery.

Mr. C. E. SPAGNOLETTI did not consider that the system of lighting advocated by Mr. Massey to be a correct one. It possessed, he thought, only one advantage, viz., that the whole of the lights could be extinguished or lighted when required, as for instance in passing through tunnels in the daytime. The expense of fitting all the locomotives and rolling stock with the necessary appliances would be extremely heavy, their being for instance, 1,557 locomotives, and 14,000 vehicles of all kinds on the Great Western Railway alone. Unless all the stock of all railways was fitted it would not be possible to run through carriages over different lines. The lighting of "slip" carriages could not be effected; also any accident that might occur would affect the whole train. He considered the "accumulator" system the only possible one, the accumulators being placed under the seats of each carriage.

The discussion was then adjourned.

NEW PATENTS—1884.

4775. "Electric arc lamps." W. FAIRWEATHER. Dated March 12.

4781. "Electric lamps." F. H. VARLEY, W. BEALE, R. H. PADBURY. Dated March 12.

4782. "Secondary batteries." S. KALISCHER. Dated March 12. (*Complete.*)

4789. "Galvanometers." A. P. CHATTOCK. Dated March 12.

4791. "Differential current meters used in charging and discharging accumulators employed in storing electricity." Sir D. SALOMANS. Dated March 12. (*Complete.*)

4794. "Apparatus for measuring currents of electricity." R. E. B. CROMPTON, G. KAPP. Dated March 12.

4828. "Telegraph posts." J. OPPENHEIMER. Dated March 13.

4833. "Insulated conductors, leads, and cables for telephonic purposes." A. R. BENNETT. Dated March 13.

3874. "Electrically actuated clocks." E. G. COLTON. (Communicated by Kick Bros.) Dated March 14.

4878. "Accumulators of electricity." J. MYERS. Dated March 14.

4896. "Electrical switches." W. LOWRIE, A. B. PICKARD. Dated March 14.

4898. "Bell dome gong or alarm for telegraphic, telephonic, and like purposes." G. WATTS. Dated March 14.

4937. "Incandescent lamps." J. S. FAIRFAX. Dated March 15.

4967. "Galvanic batteries." J. A. W. DOLLAR. Dated March 15.

4969. "Regulating the supply of gas in railway trains by electricity." W. E. LANGDON. Dated March 15.

5011. "Insulating the plate or plates for galvanic batteries, electrical accumulators, or any such like apparatus." D. HAMMOND. Dated March 17.

5012. "Electrical accumulators and such like apparatus." D. HAMMOND. Dated March 17.

5026. "Electric arc lamps." C. D. ABEL. (Communicated by T. Basilevsky.) Dated March 17.

5029. "Galvanometers." J. BLYTH. Dated March 18. (*Complete.*)

5037. "Electro-dynamic or dynamo-electric machine." H. CUSHMAN, J. P. HALL. Dated March 18.

5041. "Railway signalling apparatus actuated by passing locomotive engines, vehicles, or trains." C. E. SPAGNOLETTI, S. GRIFFITH, J. H. ROSE. Dated March 18.

5052. "Automatic telegraphs." H. J. ALLISON. (Communicated by J. Absterdam.) Dated March 18. (*Complete.*)

5069. "Secondary electric batteries." R. KENNEDY, W. FAIRWEATHER. Dated March 18.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1883.

2543. "Incandescent electric lamps for artistic illumination." B. KEELING and J. D. MUCKLOW. Dated May 22. 2d. Consists of a novel application and combination whereby incandescent electric lamps are made to produce the soft light of a sperm, wax, or other composition candle. (*Provisional protection not allowed.*)

3008. "Galvanic batteries." J. OLIPHANT, E. B. BURR, and J. W. H. R. GOWAN. Dated June 16. 6d. The inventors combine with the series of cells, forming a battery, two or more pumps worked by an electromotor or other suitable means, and so arranged that they will draw the liquids from the last cell, or pair of cells, of the series, and deliver them into tanks or reservoirs so placed that the liquids will flow therefrom into the first cell, or pair of cells, of the series. The cells are connected by means of pipes.

3271. "Telephonic apparatus." A. J. BOULT. (Communicated from C. S. Steele, of America.) Dated July 2. 6d. In this invention the inventor uses a plate of iron or steel or other material capable of being acted upon by magnetism; or a plate of wood, brass, ebonite, or of any equivalent material of a resilient nature, having secured firmly to its centre a small piece of iron about the size of the end of the magnet; the plate is firmly secured at one point of its edge to a fixed support; extending over the head of the magnet, so that the centre of the plate may be over the head of the magnet. The plate is tilted up so as to make an acute angle, with the axis of the magnet and its edge rests on one or more points, where it is held by its own resiliency, whereby tongue vibration is prevented, and tympanic action only can take place when it is acted on by the variations of the magnetic force.

3275. "Electrical railways and tramways." W. A. TRAILL. Dated July 2. 6d. Relates to improvements in that system of electrical tramways or railways wherein a metallic brush carried by the car makes contact with an electric conductor alongside the railway or tramway in order to convey the current to the electric motor on the car, and the invention has for its object to avoid damage which is now liable to occur in travelling in alternate directions, but more particularly in passing interruptions in the continuity of the conductor, and secondly to avoid liability of passers by receiving electric shocks by coming into accidental contact with the conductor.

3277. "Electrical railways and tramways." W. A. TRAILL. Dated July 2. 6d. Consists in enclosing the conductor in an envelope or casing laid beneath the ground, by preference midway between the rails, and provided with a longitudinal opening to admit of one or more electrical contact arms projecting from the car, and travelling along in the casing in contact with the electrical conductor. The said casing may be a cast iron tube, having a narrow longitudinal mouth or slot along its upper side, enclosed between flanged lips that rise up to the ground level. The contact arm that travels in this slot would be encased in a protective sheath, from which it would be insulated, and would carry at its lower end a spring contact piece (preferably of the form described in another application for provisional protection of even date herewith), which would rub against the side or top of the electrical conductor, carried upon insulating supports within the tubular casing. The necessary provision would be made in the casing at junctions with branch or other lines, and the casing would be provided with suitable manholes and drainage outlets.

3278. "Electrical conductor for telegraphic, telephonic, or similar purposes." H. H. LAKE. (Communicated from abroad by T. H. Dunham, of America.) Dated July 3. 6d. A number of wires are laid parallel to each other between two laps of raw cotton saturated with tar, asphalt or the like; the cotton laps being then compressed around the wires by suitable rollers.

3308. "Automatic switch for electric lighting." C. F. POLLAK. Dated July 4. 2d. The inventor places upon a round board (or any other insulating material) a number of receptacles as in ordinary use in the Jablochkoff System. He connects one side of all these receptacles by a wire or metal ring, and from this ring he makes one wire connection for the circuit. Upon the other side of the receptacles he places strong springs of a conducting material bent towards the centre of the Board, and working against a metal plate in the shape of a kight or triangle with a circular base next the receptacles (which base is a little wider than the space between two candles). To the middle of the base of this triangle he affixes a piece of fireproof material such as china clay, porcelain, asbestos, &c., which projects a little over the edge. This triangle is fixed by its apex to the centre of the board where he places a spring which when wound up acts on the triangle and turns it round. (*Provisional only.*)

3333. "Electric arc lamps." A. L. LINEFF. Dated July 5. 2d. The objects of this invention are: 1st—To effect a perfect and easily adjustable separation of the carbon electrodes of electric arc lamps. 2nd—To attain a very sensitive automatic feed, thus ensuring a uniform length of voltaic arc, especially when many such lamps are worked in series. 3rd—To entirely dispense with springs which in other lamps of the same type act against electromagnets, thus giving variable pressure according to the temperature of the spring. (*Provisional only.*)

3340. "Electrical accumulators or secondary batteries, &c." W. R. LAKE. (Communicated from abroad by C. Dion, of Canada.) Dated July 5. 4d. The communicator of this invention has ascertained, by means of numerous experiments, that a secondary battery, showing considerable power in ampères and in volts, can be constructed by the decomposition of chloride of sodium by means of an electric current. (*Provisional only.*)

3376. "Conductors for electrical railways." H. E. M. D. C. UPTON. Dated July 7. 2d. Consists in arranging the conductors so that they are only exposed at a number of points separated by intervals, which are nearly as great as the length of the train. (*Void by reason of the patentee having neglected to file a specification in pursuance of the conditions of the letters patent.*

3877. "Treating alcoholic liquors with electricity, to purify and impart to them the character of age." W. E. GEDGE. (A communication from abroad by A. C. Tichenor, of America.) Dated August 9. 6d. Relates to an improvement in the method or process of treating alcoholic liquors with electricity to separate and extract those acrid oils, alcoholic principles and matters of poisonous and deleterious properties which, in the ordinary course of treatment, are removed or thrown off by age.

3380. "Telegraphic and telephonic apparatus." D. SINCLAIR. Dated July 7. 6d. The object of this invention is to provide means in connection with telegraphic and telephonic lines and exchanges whereby a branch exchange may be worked automatically, that is to say, whereby the functions of the branch operator, of placing in communication any subscriber on his branch with any other subscriber on the system, may be performed from the central exchange, and the services of the branch operator may be dispensed with.

3392. "Electric arc lamps." F. M. NEWTON. Dated July 9. 6d. In the electric arc lamp, according to the invention, the carbon or electrode, or its holder, is held in position by a bush or cylinder (which may be split and adjusted to various diameters by means of a set screw), lined with a number of elastic or spring arms, fingers, or feelers, axially inclined to the carbon in

the direction in which motion is to be produced. This bush is usually made in one piece, and is rocked so that one side is rising or advancing, while the other is falling or receding, but sometimes it may be convenient to make it in two parts, divided parallel to the axis of the carbon. The feed is produced by the reciprocating motion of the lining on opposite sides of the carbon, one portion rising or advancing, while the other falls or recedes.

3413. "Manufacture of material for electric insulation. W. V. WILSON. Dated July 11. 4d. Has for its object the consolidation of wood or vegetable tar by means of nitro-cellulose, the nitration of which has not been carried beyond the point which will effect its greatest solubility, a modification of this body quite well understood.

3423. "Apparatus for applying electricity, for curative and other purposes." J. N. ARONSON. Dated July 11. 6d. Has reference chiefly to electrical brushes of the kind described in the specification of letters patent granted on the 21st day of December, 1881, and numbered 5601, and wherein there are combined a battery, an induction coil, sets of wire bristles or contact plates, and a circuit closer and push piece.

3424. "Galvanic batteries." J. GRAY, Dated July 12. 2d. The inventor employs sulphuric acid, bi-chromate of potash, and nitric acid, and sometimes adds permanganate of potash, as an exciting fluid. (*Provisional only.*)

3444. "Electric lighting apparatus, &c." J. L. CLERC. Dated July 13. 10d. Consists in their relation to machines for generating electric currents in constructing the bobbins or coils of "Pacinotti" shape, in order to allow the use of powerful inducting currents. The use of these currents being one of the causes of the increased efficiency in the production of electricity; as it allows the reduction of the quantity of the inducted wire, and thus reduces the internal resistance for a given electromotive force in the external circuit, the result being also a reduction of cost in the manufacture of the machines.

3452. "Secondary batteries or accumulators." F. M. LYTE. Dated July 13. 4d. The object of the invention is to increase the durability of secondary batteries or accumulators, and it consists, first, in constructing the supports for the active material of certain metallic sulphides, either with or without an excess of sulphur; and secondly, in peculiar methods of making the electrodes, whether the supports be composed of such sulphides or not.

CORRESPONDENCE.

The Theory of the Gramme Machine.

As Mr. Mordey denies the possibility of an iron filings diagram, like that figured in my letter of the 9th ult., existing elsewhere than in my imagination, I append a copy "engraved from the actual filings" of a diagram *experimentally obtained* by me from a piece of iron placed between two opposite magnetic poles.

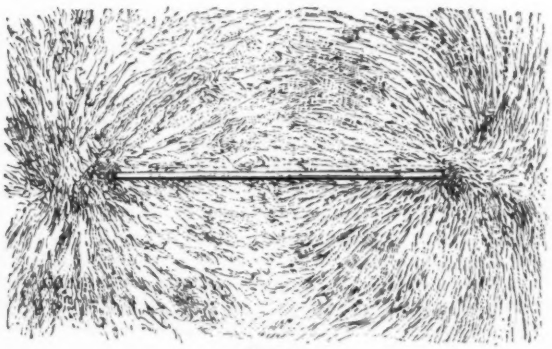


FIG. 1.

In this diagram, the lines of force flowing between the poles induced in the bar are quite visible. "Yet Mr. Mordey denies their existence!!" In the formation obtained by him these lines are not perceptible, doubtless in consequence of the shortness of the induced bar.

As to Faraday's fig. 7 plate IV., I cannot find anything in the text to show to what species of combination it refers; but experiment leads me to the conclusion that it represents the lines of force flowing from a magnet pole to one end of an iron bar. That is to say, the formation was obtained from an arrangement like that shown diagrammatically in the subjoined figure:

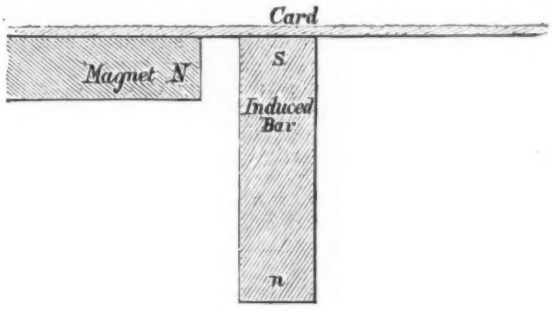


FIG. 2.

It will be seen that this arrangement is very different to that originally given by me. The positions of the bar relatively to the cord on which the filings are strewn being entirely unlike.

Appended is a diagram obtained from a combination like that figured above:—

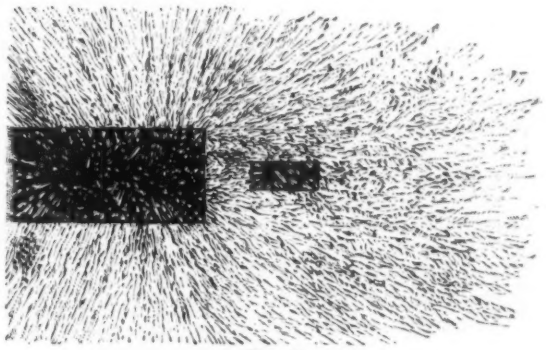


FIG. 3.

As the curves are similar to those shown in Faraday's figure, the plain inference is that the latter was obtained from a combination such as that above illustrated, and not from an arrangement resembling those from which my "extraordinary formation" was obtained.

These experiments, and the deductions therefrom, will, I think, prove to Mr. Mordey that my diagrams were not contrary to, but in accordance with, the experiments and laws of Faraday.

F. de Wolffers fils.

March 18th, 1884.

Electric Lighting.

Referring to the paragraph in your issue of 8th inst. in regard to a meeting held in Oban for the purpose of considering the question of electric lighting, I think it desirable to explain that the statements in the paragraph are accidentally misleading. This is doubtless owing to the representatives of the local press having noted certain incidental remarks which had no relation to one another.

As the information in your valuable paper is generally so reliable, I have thought it right to send this correction, lest other districts might be misled by the figures given.

C. T. Grant,
Superintendent.

[If Mr. Grant had pointed out in which portion of the note the misleading statements occur, his letter would have been of some value. As it is, our readers are left as wise as they were before.—[EDS. ELEC. REV.].

Applications of Electricity.

A company desires to empty a mine, under 500 acres, in a virgin coal field, containing the estimated quantity of 21,000,000 tons of minerals, from a 7 ft. shaft 165

yards deep, and to convey the minerals to the main line and river, 3⅛ miles from the pit, at the rate of 500 tons per day at the least. The minerals dip about 1 in 3. The mine is free from water and explosive gas.

Is electrical science sufficiently advanced and perfected to enable this to be done as or more efficiently by electrical power, and at a saving of cost over present system of steam power? viz :—

Light the mine with electric light. Work the underground workings, and wind up the minerals to the surface by electrical power. Convey the minerals to the main railway and river by branch railway, either on surface or overhead, by electrical power, and propel barges and long boats on the river by stored electric power.

If it is, I shall be glad to receive and give information on the subject.

John Thompson.

7, Pierpont Street, Worcester.
March 17th, 1884.

[Electrical science is sufficiently advanced to accomplish everything mentioned by our correspondent, but at what cost is quite another matter. We cannot think it could be done so cheaply by means of electricity as by steam, unless water-power in plenty is available for driving the dynamo-electric machines.—EDS. ELEC. REV.]

Dynamo-Electric Machines.

In the Editorial remarks with which you have honoured my experimental demonstration of the superiority of the Pacinotti armature over that of Gramme, you have invited further discussion on several points. May I be allowed to say in response, that no one would be better pleased than myself that the whole question should be ventilated and discussed, and for that end I am intending to bring this and other experimental researches on dynamos at an early date before the Society of Telegraph Engineers and Electricians. Until my paper is read there I cannot very well anticipate what I shall have to say on that occasion.

Silvanus P. Thompson.

University College, Bristol,
March 17th, 1884.

[The more we ponder over the experiments of Professor Thompson, to which we alluded last week, the more unsatisfactory we deem them to be. We are glad to note that he intends bringing the matter before the Society of Telegraph Engineers, where, we hope, the matter will be so far discussed as to enable a satisfactory decision to be arrived at upon many points that are now somewhat doubtful.—EDS. ELEC. REV.]

Non-Sparking Keys.

Allow me to say that non-sparking keys are not quite so novel as Messrs. Ayrton, Perry, and Jamieson seem to think, for in 1871 a non-sparking key was designed and made by me for the present Earl Crawford, then Lord Lindsay, its use being to connect and disconnect or reverse the direction of current (a very powerful one) of 120 volts, used for magnetising Lord Lindsay's monster magnet. The arc produced by the magnetic current on interruption gave between copper terminals a green flame of upwards of three inches in length, and as it lasted a few seconds was capable of melting the terminals and doing other considerable damage. By the use of the sparkless key this was prevented.

The arrangement or construction of the key is somewhat different in form, but essentially the same in principle, and in the introduction of graduated resistances, as that recently employed by Messrs. Ayrton & Perry. But it provided, in addition to this, the means of changing the direction of current, which I consider of great importance in non-sparking or other keys used for electric lighting when such can be readily effected, and it is also very desirable when charging accumulators to have the power of reversing the direction of the dynamo current, and thus for experimental use the stored-up potential may be employed in addition to that of the dynamo current, which is sometimes of very great convenience.

Fredk. H. Varley.

Mildmay Park Works,
Mildmay Avenue, Ball's Pond,
London, N. *March 17th*, 1884.

Electro-Magnets.

It is a common misconception to assume that the strength of a magnetic field varies with the size of an electro-magnet instead of only with the density of current in the electro-magneto coils; but that this is wrong is strikingly proved by the aid of the Edison or other large dynamo field-magnets, as a key or other small piece of iron can be as easily pulled away from an electro-magnet weighing several tons as from an electro-magnet weighing only as many ounces. But since the size of the magnetic field varies with the mass of the electro-magnet, when these large electro-magnets are provided with armatures proportionate to their size, they then exert a force proportional to their mass.

This fact of the strength of magnetism being independent of the size of the electro-magnet, suggests a somewhat interesting problem. For if one electro-magnet has N^3 times the mass of another, then each molecule of iron of the larger electro-magnet will have N^3 times as much current acting upon it at N times the distance of that of the smaller electro-magnet; but since the strength of magnetism produced in both electro-magnets is the same, it follows that, either *the action of the current upon the iron must be universal and vary as the inverse cube* $\frac{1}{N^3}$ *of the distance*; or, *if the action of the current upon iron varies as the inverse square of the distance, its action upon a molecule would not be universal, but would vary as the inverse cube root of the mass acted upon within the same solid angle.*

I notice that recently Messrs. Crompton and Profs. Ayrton & Perry have both constructed galvanometers on a principle that assumes this latter law as true, although until this question is settled experimentally, the former law would appear to be equally as plausible.

W. Moon.

Bell's Telephone Patents in England.

I am loth to further take up your space by prolonging a discussion on subjects which can be interesting to only a small minority of your readers, to the exclusion of more important matter, but as I apprehend that it is foreign to your wish that error should remain uncorrected in your pages, I must ask permission to call attention to the last paragraph of Mr. Barney's letter, which appeared in your issue of 8th inst. At the close of that paragraph Mr. Barney says that the Statute of Monopolies, of 21, James I., 1623, contains the following sentence:—"Inventor means the person who first introduces the invention into Great Britain." Now, as a matter of fact, *no such sentence or anything like it* is to be found in the said statute, which indeed contains no definition whatever of the term "Inventor." The courts have always held that the first importer was an inventor within the meaning of the statute, but to say that the statute itself gives that definition is an egregious mistake.

I can quite understand Mr. Barney treating my former letter with silence, for the simple reason that, like the present one, it is unanswerable; at the same time, I cannot but think it would have been more courteous to your readers had Mr. B. frankly confessed his mistake. We are all fallible, and it argues no loss of self-respect when convinced of an error to candidly acknowledge it.

Thos. J. Handford.

42, Southampton Buildings.
March 17th.